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ON SOME POINTS OF PRACTICE IN IRON FOUNDING.

No. XV.

In concluding our last paper we stated that before leaving the subject of pits we should make some remarks on their peculiar uses and advantages, and as to the modes of working them. To take the latter first will be most convenient. As regards digging out we have said nearly all that is important. As respects ramming in again, however, something remains to be said in addition to the remarks already made. The ramming in of a large pit round a ponderous loam mould, is always a work demanding the expenditure of a vast deal of human labour. Twenty foundry labourers, beating time with their rammers in a sort of dull recurring *refrain*, and going round the mould in the pit in four radial ranks for hours, as the sand is being slowly and evenly thrown in to them, is by no means unusual; and a couple of skilled moulders besides to watch the perfect fulfilment of this mere brute-force work in the pit, and the foreman of the job probably "kicking up his heels" on the bank, is altogether no unusual spectacle.

Now, although we are not aware that it has ever been before proposed, much less tried, we believe there would be no difficulty whatever in arranging extremely simple machinery by which almost the whole of the ramming up of the great bulk of the sand might be performed. Nothing could be much simpler than to construct a vertical light frame, situated in a radial plane, and being centered to either an actual or an imaginary spindle at the centre of the pit and mould, which should contain and guide a range of rammers (something like a range of stampers for crushing ores, but much lighter), which should in succession be lifted each about 15 or 18 inches, and dropped upon the sand. Two or, if necessary, more of these radial frames might be at work at once, and motion to the whole of the rammers be given either by a small steam cylinder, &c., mounted upon the common centre to all the frames, or by a belt or band, or elastic rope, passed from some fixed source of power in the shop to the central point, and thence to the rammers of each frame. The whole apparatus should be sustained by some simple form of overhead movable frame, so as not to interfere in any way with the mould occupying the centre of the pit. These machine rammers, or steam foundry labourers, should not approach nearer than a foot or so of the "cope" of the mould, for fear of some unlucky blow upon that, but may go as close as practicable to the circumference of the pit itself. There would, therefore, remain a certain small amount of hand ramming still to be done, and this should be accomplished by one or two labourers at most, under an assistant moulder's eye.

Wherever there might be a large run of pit work of a character requiring unflasked or brick "copes," and therefore ramming up in sand, we believe some such arrangement as this would be found "to pay." The whole apparatus admits of being constructed of great simplicity and cheapness, and from the lightness of the rammers employed, never exceeding ahead of some 24 lbs. weight or thereabouts to each rammer, it might be of perfect flexibility in its adaptation to all diameters and depths, &c., of pit and moulds.

We shall add but one other paragraph of remark upon pit management. It is by no means unusual with loam moulders when extracting their mould and casting, after having been poured and cooled from the pit, to drag it out in part by main force by means of the cranes. After having dug down round the mould to within as many feet of the bottom as the moulder deems shall have so far diminished the resistance of the sand around, that the remainder is likely to yield to the pull of the crane, and having probably loosened more or less (to a small depth) of the remaining 4, 5, or so, feet of hard rammed sand, he gets one or more chain slip slings round the outside of the cope and casting, or of the casting alone, if this has been partly "stripped" of cope in the pit, and hooking on one or more cranes, gets on a strain, usually a severe one, and gradually tightening this, at intervals waits until he finds the sand giving way below, and that the whole mould and casting have "started" out of the sand, when of course it can be hauled up out of the pit readily enough. In our judgment, however, this is a procedure that should never be permitted in a well-managed foundry. The resistance afforded by well-rammed sand, to lifting out of it the heavy mould it grips, is always very great—no man can tell how great in any particular case. There are no means of judging of the strain visited upon the cranes by thus tightening them, upon an object anchored, as it were, into the earth, except by the men at the crane being "brought up dead," *i.e.*, able to turn no longer, if it be a manual crane; nor any means at all except the "taut feel" of the chains if it be a steam crane. The strain, to be of any use at all, must be one amounting to many tons; and the upshot is, that ere now the first notice of the severity of the bite has been the breakage of the crane chain, or of something else: and even if all stand good, the cranes, in the mind of any reflective mechanic, are no longer so safe as they were, perhaps no longer safe at all, for they have been exposed to a greatly more than normal, and to an *unknown* load, and for aught that can be predicted, may be so strained that at some future and critical moment, under a much less load, failure may occur. But this is not all: large hollow loam castings, before they are quite cold, while if not still "black red" in some parts, they are yet as hot as the melting point of lead perhaps, are anything but *rigid* bodies. Nothing is easier than more or less to distort their forms by any serious amount of external force, and we have actually known a tolerably large pumping engine cylinder, by having been thus tried to be dragged out of the pit with a slip chain sling, and the pull of two cranes from that both *at one side* of the cope, not only made oval, but *bent* enough in its length to render it very doubtful whether when bored it might not prove too thin in certain places for use. Besides, there is really little or nothing gained in the way of time or labour by this operation; for the bricks and so forth, more or less of which are always dragged off and left behind, must be cleared up out of the sand, and the latter ought (if the foundry be properly managed) to be wetted and tempered before being filled in again and rammed into the pit. We need scarcely recur to the steam rammers we have suggested, that their use would be nowhere found more advantageous than in the filling in of the empty pit, where, indeed, they could perform unattended the whole of the work, the sand being merely pitched in to them.

We pass now to another subject. The *necessity* for pits has been already referred to, *i.e.*, the reasons why they are indispensable as foundry appliances; but some remarks remain to be made as to their

value, which consists in the facilities they present for making upright castings, *i.e.*, for casting elongated objects in a vertical position, so as to obtain the advantages due to the pressure of a more or less great *head* of liquid metal in the pouring and consolidation of the castings so made. The general fact that "casting upright," as it is commonly called, is good, and that it tends to make sound and good castings, and that the metal itself is in some ways improved as compared with the same casting made on the flat, has long been matter of nearly universal information with the ironmoulder. But even at the present hour there is very little accurate information in existence as to the precise nature of the improvement, or the precise extent of it. Indeed, the only experimental results upon the subject pretending to exactness are those made some years ago by Mr. Mallet, while engaged practically himself as an ironfounder. In fact, the conduct of such experiments, which must, to be made at all, be upon a very large scale, is too expensive for private individuals; and their prosecution upon a complete scale would be a suitable and valuable work to be done at the expense of some of our learned bodies, or by the state.

Some advantages, which may be said to be purely mechanical, result from vertical casting. These are chiefly, that the employment of the "rising head" (*masselot* of the French) affords a fine gathering place for dross, slag, or scoria, out of the way of the casting itself; that this head affords the very best position and the utmost facility for "feeding" into the casting, hot metal, and for "pumping" it with iron rods during the process of contraction and consolidation—a process, however, which is often carried too far, *i.e.*, carried on much too long: for if carried on beyond the point whilst the metal in the interior of the casting, though getting thick and viscid, is still absolutely *a fluid*, every movement afterwards tends to disturb and loosen the particles of the casting, the iron in which has arrived at its most brittle and crumbly state at any temperature; lastly, vertical casting conduces to the escape of included air bubbles in a very high degree, inasmuch as any bubble, like a balloon ascending in air, acquires a higher velocity, that is, a greater power of ascent, the longer the column of liquid metal is through which it ascends. It results that all other things being the same, from these causes alone upright castings are, or ought to be, much sounder than those cast on the flat. But for all that, the whole of these advantages are not unfrequently rendered nugatory by the ignorant way in which the metal is thrown into the vertical mould.

While cast-iron guns continued to be made (even at Woolwich), the practice was to prepare an open-topped encased (or flasked) loam mould for the gun, comprising the rising head, and having placed it vertically in the dry pit, to run the metal right into the open top from a shoot from the tapping hole of the air furnace, and permit the stream of metal to drop a depth at first of 10 or 12 feet into the bottom of the mould, which it gradually filled; the amount of oxidation going on, as the long stream of liquid iron passed through so much free air, was obvious to one regarding the halo or column of scintillations that surrounded the whole length of it. All this oxide, all the slag or scoria went into the mould, was well churned up into the metal by the impulse of the falling stream; and at last, when the rising head was full, it was plain to any exact observer that air and foreign matter involved in the metal throughout its entire volume continued long slowly to disengage itself, more and more imperfectly as the outer parts of the mass consolidated, and that much of the oxide at least thus swept in was never disengaged at all. Although with such malpractice the other or molecular advantages of vertical casting to which we are about to refer, were still in part realized, those which we have above described as the mechanical advantages were neutralized. Yet we have heard that practice defended at the once greatest gun foundry in the North of England, in the offhand phrase of "the practical man," "If the air and the dross go in they are sure to come out again." We shall only say, the Americans in casting their Rodman guns, the manipulations for which we shall hereafter describe, are not of that opinion. They practise that which we affirm to be the true and only method to obtain the full advantage of all vertical casting—pour by vertical gaits external to the casting and reaching to its lowest part; let these be of a size to be kept in pouring *quite full*, so as to carry down no air with the metal, and let the metal rise up within the mould until it reaches the top of the rising head, as free from any disturbance as possible. The difference of appearance in the top of the rising head itself, when it shows at top, is enough to prove to any practised eye the value of this as compared with the other method. In this case it rises up a *comparatively* solid mass of metal, with rounded flowing edges and a pretty flat top; in the former it is a perfect comb of pores and holes, of air holes and dirt.

Wholly independent of these mechanical conditions, however, advantages are obtained by vertical casting, that is, casting under pressure, which depend upon the molecular changes induced in the cast iron itself, in the course of its filling the mould and becoming consolidated. As to the precise nature of these changes our own impression, as derived from converse and observation, is, that ironfounders in general are almost in entire ignorance, and for want of precision of thought upon the subject often fail to derive the advantages they might practically obtain, and sometimes fail to see the causes of their failures when employing the method in practice.

Some observations of a theoretic character, therefore, may not be out of place here. The highly complex chemical compound to which we give the general name of cast iron, varies in the pig, or in castings of equal size and made in the same way, in specific gravity from about 6·200 to as much as 7·800 or thereabouts, an enormous range of difference. In any two different *makes* or specimens of cast iron a great difference of specific gravity may be due to actual difference in chemical constitution; the two are not the same compound of metals and of metalloids at all, though they both go by the same name; and owing to this, *it may be* that the cast iron of the smaller specific gravity may be of greater tensile or compressive resistance (or of both) than that of the higher specific gravity. Hence that which has been stated as resulting from numerous experiments is undoubtedly true, that a mere comparison of specific gravities of different makes of cast iron affords no criterion of their relative passive strengths. Not but that it is certain, if we had exact analyses of a sufficiently large range of various makes of cast iron, and could compare these with their specific gravities, so as to discover what particular chemical constitution (within the range) gave the highest specific gravity; and that we had also the relative passive strengths of the whole range, we should be able to assign generally the relation that subsists between strength and specific gravity. But although this remains as yet unknown, there is no doubt whatever about the fact that *for any one given make*, i.e., *for the same cast iron, the strength is greater as the specific gravity is higher*, though in the ratio of what function of the specific gravity we do not yet know experimentally.

There is good ground, however, for assuming that the increment of strength is directly as the specific gravity, and for this plain reason, that as the resistance of an unit of section is proportionate to the quantity of material represented by that section, and as the quantity of material therein is directly as the specific gravity, so must the resistance in the same material for the unit of section be as the specific gravity. Difference of crystalline arrangement, if influencing specific gravity and structure at the same time, and therefore *possibly* resistance, would seem to be the only condition capable of throwing any doubt upon the generality and certitude of this conclusion as regards all inorganic homogeneous bodies. In the present case crystallization does play a part, though a subordinate one.

We come, then, safely to this conclusion, that with whatever sort of cast iron we may be dealing, the higher we can exalt its specific gravity by any of the processes of casting, the more resistant we shall make the material to external forces. Now this is just what we most readily effect by vertical casting under the pressure of a deep head of metal.

Stated generally, the conditions determinant of the variation of specific gravity in *the same* cast iron, as evoked in the process of casting, are—

1. The bulk or volume of the casting, including its form, *i.e.*, whether under a given volume it have a great proportionate surface, by being very long or thin, or the contrary.

2. The depth of head of liquid metal under which the casting is made and cooled.

3. The temperature at which it is poured, *i.e.*, more or less above the mere fusing point.

4. The rate at which the casting has been cooled.

For the present we keep out of view altogether those changes in the condition of the metal which are produced by *chill casting*. That process involves at once alterations in the chemical constitution and in the molecular arrangement of the metal, as well as in its specific gravity, which is always thus increased, but does not belong to our present subject, and we shall treat of it separately.

The following table, No. 1, gives the results obtained by Mr. Mallet,

by a series of experiments made upon a large scale to determine the rate of increase of specific gravity producible in the same cast irons by vertical casting under heads of liquid metal gradually increased from zero up to *fourteen feet* of head. The experiments were made upon three different and characteristic makes of cast iron—viz., Calder, Scotch iron; Blaenavon, South Wales, noted for its great strength and large contraction in cooling; and Apedale, Derbyshire iron—and in each case the masses cast were the same in form and size, viz., cylindrical shafts of about 4 inches diameter cast in dry sand moulds, and poured by gaits at the bottom; the temperature of the respective metals and the rate of cooling being preserved as nearly alike in all as practicable. These experiments were published by their author, in his second report upon the action of air and water on iron, in the Transactions of the British Association, in 1840, and having there appeared in direct connection with an inquiry of technical chemistry only, have been but little known, and have not attracted the attention they demand as *the only experiments*, so far as our knowledge goes, made up to the present time upon this important subject.

No. of Experiment.	Calder Cast Iron, No. 1. Hot Blast.			Blaenavon, No. 1. Cold Blast.			Apedale, No. 2. Hot Blast.			Quam Prox. Pressure, when Fluid, in Lbs. per Square Inch.
	Depth of Casting in Inches.	Specific Gravity.	First Difference.	Depth of Casting in Inches.	Specific Gravity.	First Difference.	Depth of Casting in Inches.	Specific Gravity.	First Difference.	
1	0	6·9551	—	0	7·0479	—	0	7·0328	—	·0
2	24	6·9633	·0082	24	7·0576	·0097	24	7·0417	·0089	6·4
3	48	7·0145	·0512	48	7·0777	·0201	48	7·0558	·0141	12·8
4	72	7·0506	·0361	72	7·0890	·0113	72	7·0669	·0111	19·2
5	96	7·0642	·0136	96	7·1012	·0122	96	7·0789	·0120	25·6
6	120	7·0776	·0134	120	7·1148	·0136	120	7·0915	·0126	32·0
7	144	7·0907	·0131	144	7·1288	·0140	144	7·1046	·0131	38·4
8	168	7·1035	·0128	168	7·1430	·0142	168	7·1183	·0137	44·8

The greatest fluid pressure here employed—that due to 14 feet head—is about equal to 44·8 pounds per square inch of lower part of the casting. The results show that in each of the three makes, the irons which cast under no pressure had the specific gravities in column 1, have, under a 14 feet head, those in column 2:—

	Head = 0.		Head = 14 feet
Calder,	6·9551	...	7·1035
Blaenavon,	7·0479	...	7·1430
Apedale,	7·0328	...	7·1183

So that the total increments of specific gravity were—

Calder,	0·0128
Blaenavon,	0·0142
Apedale,	0·0137

The densities continue to increase at each increase of 2 feet of head up to the very end, but the increment is a slowly decreasing one. The increase is rapid at first, up to a total head of about 6 feet in the Calder, and to about 4 or 5 feet in the Blaenavon, and then decreases and becomes a very slowly converging series, approximating to a common difference of about 0·013 for each 2 feet of head within the limits of range of experiment.

These results are not sufficiently extended to enable us to get any *exact* expression for the law of increment if continued to much greater heads of metal; but they would seem to indicate that the increment would not be exhausted at even three or four times the pressure here employed at the maximum.

Taking the average of the whole three makes of iron experimented on, the increase of specific gravity is in the ratio of 7·01193 : 7·12160, or in that of 1·000 : 1·015; and if we assume (as above) that the increment of strength in the same iron is as the increment of specific gravity, we have here an increase of strength, due to casting under a head of 14 feet, of one and a half per cent—a by no means insignificant gain. But this does not in reality represent the entire advantages practically procured; for besides the great comparative freedom from air bubbles, due to mechanical conditions already referred to, it is a fact—though one that our knowledge of the still very obscure subject of crystallography does not enable us clearly to explain—that the size or development of the integrant crystals, after cooling, of the same cast iron, is sensibly finer and smaller when cast under a considerable head, all other things being the same; and this in itself very considerably adds to the strength of the casting made, there being no room to doubt but that all divisional planes between the integrant crystals of cast iron (as in all other crystalline bodies) are planes of weakness, and that as these are developed larger, so is the weakness due to them greater.

The value to be derived from casting under pressure was recognized nearly fifty years ago by the late John Oldham, senior, engineer of the Bank of Ireland, in concert with Mr. John Mallet (the father of the above experimenter), with a view to thus casting the "tables" for bank-note printing presses. The method proposed was that of pouring the metal into dry sand (waxed) moulds exhausted of air, so that the metal was exposed on the instant to the pressure of one atmosphere, and this was directly afterwards increased at pleasure by admitting compressed air in upon the top of the mould, so as to bear upon the "rising head." A very analogous method of treating glass when in fusion for optical or other purposes, was, we believe, at a subsequent period patented by Mr. Bessemer; and within a very recent period Mr. Whitworth has patented and brought into practical use the application of great mechanical pressure in making castings in homogeneous iron or in steel. It is true, Mr. Whitworth's views have regarded chiefly, if not exclusively, the getting rid by compression or by expulsion of the bubbles of air, or probably of carbonic oxide, which are generally included more or less in these metals, but he will necessarily obtain the advantages of increased specific gravity in his material, and his methods are, no doubt, equally applicable to cast iron. For ordinary foundry work, however, the pit affords the ready means of vertical casting, and of insuring a largely improved standard of goodness in all castings so made, in preference to pouring on the flat or in an inclined box. The facts are well known, and now for a good while almost everywhere acted upon, by the large pipe foundries, but it has not extended as a practice much further. It may be just remarked, as a physical fact, that, in accordance with the general law, the cast iron in a very deep mould under heavy pressure must have the freezing or "setting" point of temperature of the metal, while so under pressure, slightly exalted; but the extent of this is probably much too small to produce any practical effect.

We shall revert to this in our next paper, in which we propose treating of the effect of mere *increase of bulk* upon the qualities of the same metal when cast in the same way, and to make some remarks as to the effect of repeated meltings of cast iron, a subject upon which some very erroneous doctrine has been promulgated.—Ed.

RECENT IMPROVEMENTS IN ELECTRICITY.

Late events have repeated what has been so often before remarked in the annals of science, that two or more men eminent in the same line of research should, almost at the same moment, produce to the world a discovery or an invention almost identical, and yet, so far as evidence goes, without any previous passage of information from the one to the other. A few weeks ago Mr. C. Siemens forwarded to the Royal Society a communication "On the Conversion of Dynamic Force into Electrical Force, without the intervention of Permanent Magnetism." The paper remained some week or eight days in possession of the Royal Society, as we have understood, before it could be read. In the interval, Mr. C. Wheatstone sent in a paper "Upon the Augmentation of the Power of a Magnet by the reaction produced upon it by Induced Currents, of which it is itself the origin." The two papers were brought forward upon the same evening, and then proved to contain statements of facts, principles, and deductions from them, almost identical. The shave as to priority is very close, but as it appears to us (assuming the facts to be just as we have heard them, and as stated above) it nevertheless belongs, upon all established principles, to Mr. Siemens, as being the one who first placed his communication in the hands of the Royal Society, which, as regards the world of science, must be held as equivalent to publication.

However, it is not for us to decide such a point, and we pass from it to the matter itself of the two communications, which appear to us to mark a most important advance in electrical science—one, indeed, the value of which in application it is difficult as yet to see an end to; for it amounts to this, that now for the first time we are in possession of the means of converting mere "mechanical work" into electrical energy or work, upon any scale howsoever vast, without the necessity for any

permanent magnetic intervention, whether derived from the ordinary hard steel permanent magnet or from the electro-magnet, and also without the necessity for any battery or rheomotive power.

Nothing is simpler than the statement of how this wonderful result has been arrived at. It has long been known that if in front of the poles of either a permanent (ordinary) or an electro-magnet, an iron armature, which itself is coiled round by an insulate wire in the direction transverse to its length and to the plane of rotation, be caused to revolve, that a current is generated in this coil, which at each making and breaking of contact with the magnet and armature is changed in direction, but which, by the introduction of a commutator, may be caused always to pass in the same direction, and in this way a more or less powerful rheomotor obtained. This is, in fact, the common magneto-electric machine, the magnet or magnets of which may be either ordinary terrestrial magnets of hard steel, or may be electro-magnets of soft iron temporarily magnetized by the circulation of a current round the iron in a transverse direction, obtained from a battery of one or more cells. Now let us suppose a single piece of soft iron bent into the form of a horse-shoe magnet, and surrounded with a coil of wire in the usual way, and provided also with the revolving iron armature, which is slotted out in a direction parallel to its faces, so that it may itself be clothed also with the usual coil of insulated wire: if the iron be *absolutely free* from any *permanent* magnetism, or from any *induced* magnetism from the earth, or from any *electro*-magnetism induced by the circulation of any current through the horse-shoe coil, then the armature may be caused to revolve, but no electricity will be produced. Let, however, only for an *instant*, a current, be it ever so feeble, be passed through the horse-shoe coil, then for the instant the horse-shoe iron will be converted into an electro-magnet, it may be one of extreme feebleness. If now, even after the current has been broken and ceased to pass any longer through the horse-shoe coil, the armature be caused to revolve in face of the poles, some electricity will be produced, however feeble. Under those the ordinary conditions, however, it will be too feeble to be of any use, may be too feeble to be even perceptible, and may gradually become in any case evanescent. If, however, the extremities of the wire of the armature coil be now connected with those of the horse-shoe coil, the moment rotation is given to the armature the feeble current generated in it, in place of being passed off elsewhere, is passed through the horse-shoe coil; it therefore instantly exalts the small residual magnetism of the horse shoe into that of an electro-magnet; but by the very next revolution of the armature, before this now more powerful magnet, an increased current is produced: this passes round the horse-shoe magnet and further exalts its power, and so on until in a few turns the horse shoe has become as energetic as it is possible to be as an electro-magnet. At this moment the mechanical resistance of the armature to rotation is powerfully increased. By simple arrangements, which differ in detail in the machines of Siemens and of Wheatstone, a part of the current through the electro-magnet is diverted, and may be employed in other ways. With the Wheatstone machine, 17 centimetres of platina were ignited, the whole instrument being of very small size, but requiring, from the heavy resistance of the armature, the power of two men to cause it to revolve.

Having described thus much, it will be evident that, as stated by Mr. Siemens, it is not necessary to initiate the action by the help of a battery at all. It is sufficient merely to touch the soft iron horse shoe, for even a moment, with a common permanent magnet, so as to induce momentary magnetism in the former, and we can then go on. Even this is not necessary: because as every soft iron bar, if placed parallel to the earth's axis, or in our latitude even in a vertical position, becomes a feeble magnet by terrestrial induction; so, if the horse shoe be placed upright, it is only to rotate the armature and almost immediately powerful effects are produced.

In this singular combination there seems at first sight to be a nearer approach to perpetual motion than ever before; in reality, however, there is nothing of the sort, nothing a bit more so than in the steam blast in the funnel of a locomotive, which is more powerful as the steam pressure due to the urgency of the fire is greater and the speed faster: which results again depend upon the blast itself, *in degree*, but the motor still lies in the combining of the coal and the oxygen. The result in this case is that by the help of mere mechanical power, or "work," we can now produce electrical decomposing, light-giving, or calorific effects without limit, and without either steel magnet or battery power. It is difficult to over-estimate the important applications that this may give rise to.

Both these instruments were shown in action at the anniversary meeting of the Royal Society at Burlington House, on the evening of the 2nd March (instant), and with them was shown, as the great lion of the meeting, the amazing magneto-electric machine of Mr. H. Wilde, of Manchester, which in its construction has a great analogy with those of Wheatstone and Siemens, indeed depends on principles in themselves identical with those of the above. This machine, which, as exhibited, is of colossal proportions, was driven by a steam engine of eight or ten horse-power. It consists of some eight or ten vertical electro-magnets, each of a round iron bar placed vertically, of some 4 feet long by 4 or 5 inches diameter, and wrapped round with about 14 cwts. of insulated copper wire. These are ranged in two parallel ranks, and a large compound armature is arranged to rotate between the lower poles, driven by a strap, the shaft of the armature carrying its coil of wire. Upon top of all this is placed a battery or crowd of some twelve to twenty permanent steel horse-shoe magnets, with their planes vertical, and provided with a revolving armature also driven by the power, and with the necessary rheotrope or commutator apparatus. All this is relatively very small, the horse-shoe magnets being only about 12 inches in length of fork, and of flat steel, about 2 inches by $\frac{1}{2}$ inch thick. When rotation is given to both armatures, the current generated by the permanent magnets, as developed at their armature, is passed through the great coils surrounding the electro-magnet bars; these converted thus for the time into enormous electro-magnets, each capable of lifting probably several tons, by the rotation of their own armatures and rheotrope developed such a current of electricity as in its effects far surpassed anything that we at least had ever before witnessed; and if we may judge by the enthusiasm excited not only in every member of the Royal Society present, but in such men as Wheatstone, Tyndall, Siemens, Miller, Stokes, the President, and others who are *au courant* with all that is doing in electric science in all parts of the world, produced such effects as have never before been seen. It was indeed a grandly impressive exhibition of the power that man has now achieved over the most subtle elements of the world in which we live.

With the great armature rotating from 1200 to 1500 times per minute, the light produced from two charcoal terminals, each as thick as a man's finger, placed in the focus of a parabolic reflector, was more dazzling, or rather more perfectly blinding, than that of the light of the unobscured midday sun. At the length of the lower library, probably above 100 feet, the nearly parallel rays sent off from the reflector were not merely sensible, but *hot* to the hand. At half the length of this long room, a hole could be burnt in paper in a second or two by concentrating the heat rays by a common pocket lens. There was no intermittence in the light—a steady, colourless, dazzling blaze—a veritable artificial sun—before which the "sun-burner" gas lights looked brown and smoky, and in which coloured objects assumed many curious changes. Amongst these we remarked that several but not all the black coats present assumed a distinct purple tint. The spectrum of the light, as seen through many spectroscopes (of which a large number by Mr. Browning, of the Minories, were exhibited), was very glorious and remarkable, and made one long for quiet and time to examine them more closely. When the armature was changed, and the speed, for conditions fitted to evolve quantity and less intensity, the calorific powers of the gigantic instrument proved indeed a new source of wonder. Iron wires of a quarter of an inch diameter, and about 22 inches or 2 feet long, placed between the vices of the terminals, became luminous in about fifteen seconds, were white hot within perhaps the first minute, and within three or four sunk and dropped to pieces in great, soft, and nearly fused fragments. Had there been any means of supporting the iron it would have been absolutely liquefied. The iron, after being cooled, exhibited some singular and unexplained phenomena which appear to deserve further investigation. The interior substance of the wire had become hollow and spongy, and in part crystalline; all trace of fibre in the drawn wire gone; but what was more remarkable, along the whole of the exterior of the cylinder, but at various sides and discontinuous as to length, there were *gerçures*, nicks or longitudinal cracks, extending inwards about one-fifteenth of an inch, and open at angles of about 35° to 50°, like the cracks in an over-ripe melon, as though some repulsive force radial to or tangential to the surface of the cylindrical wire had acted upon the metal. The whole surface was coated with "hammerschlag," iron scale oxide, intensely hard, black, and glittering. A platina wire,

of rather more than a quarter of an inch diameter (by the eye), and about 2 feet long, lent by Mr. Matthey, was ignited, glowed for some two minutes or so with a brilliancy that became at last "dim with excess of light," really giving forth a blue and then a purple blue light from its central part (of its visible surface), and a yellowish white from the edges, and then suddenly dropped in large fragments, so soft and nearly in fusion that they altered shape by the fall of only 6 or 8 inches. When we consider the rate at which heat must have been carried off from this incandescent wire, with its enormous excess of temperature above that of the air of the room to which it was freely exposed, both by radiation and by evection, we may well wonder at the tremendous heating power that yet was able in open air to effect this. It was stated that Mr. Wilde's machine is about being applied by a French company to the lighthouse at Cape Grinez; if so, there can be no doubt that it will be seen right across the channel in England, if sufficiently elevated above the horizon. The cost of the light is estimated at about 8*d.* per hour, and if so, can as to cost compete with oil. There are several other points by no means yet determined, however, as to the general suitability of any electric light as applicable to shore-light purposes.

That this machine will supersede others for electro-plating, &c., there can be little doubt, and that it will find many chemical and other applications, there can be as little. The smell of ozone in the large Royal Society's room was very distinct. As a generator of that form of oxygen, it will probably be hereafter employed by bleachers of calico, linen, sugar, and many other things, and it is not too much to say that the day may not be very far off when it may become a powerful metallurgic instrument. Electricity has indeed had quite a sudden jubilee, not only in London but in Paris, where, at the latter end of the last month, the Abbé Moigno lectured upon its recent advances and applications, by invitation, before the emperor, in the Grand Salle des Maréchaux at the Tuileries, assisted by many of the first physical experimentalists and instrument-makers in France. The effects elicited from the marvellous machines of Bertsch (a modification of that of Holtz) and of Hempel, and the electric brake, applicable to railways and to all machinery, are said to have excited the liveliest interest on the part of the emperor. We have not space, however, to refer further to these at present.—Ed.

Note.—We find the great induction magnets in Mr. Wilde's machine are formed of flat plates, *i.e.*, having a parallelogram section horizontally, round which the wires are coiled, and not of cylinders, as they appear externally to the eye, and as stated above. We shall probably be enabled to present our readers hereafter with an illustration of the machine.

IMPROVEMENTS IN SADDLERY AND HARNESS.

Horse gear of all sorts has been one of the most singularly unprogressive things in the entire circle of every day appliances of life, civilized or uncivilized. The horse gear of the *ιπποδαμοιος Αχιλλευς* differed in very little, so far as we can gather from Homer, from much of the horse furniture of to-day, either in this or in other countries. The iron horse-shoe, said to have been first nailed to the hoof 800 years ago by William the Conqueror, remains the same barbarous and, upon our paved streets or frozen roads, inefficient affair, it became from the moment that hard roads were constructed in the forenoon of our north of Europe civilization. It may fairly be doubted whether the pad-shoe of plaited straw of the Tartar be not at once a more refined and effective contrivance for protecting the hoof from percussion, and yet without becoming incompatible with the animal's remaining upon his legs. In every strap and buckle in which the horse harnessed for draught is encased, the same sort of absence of thoughtful adaptation of means to end, the same following in some old and older rut of habit, are more or less apparent.

In four-fifths of the cases that may daily be painfully witnessed by any humane man, of horses jibbing, or stopping, or backing and refusing to go farther, often under any amount of cruel punishment, it would be found, by a really observant eye, that some part of the *impedimenta* of the poor brute, with which under the name of harness he is hampered, is so oppressive that it is torture to him to proceed. Most commonly it is that "the collar" is pressing so upon the shoulder or neck muscles as to compress these in upon the windpipe near its base, and tend to suffocate the horse.

A simple broad flat band of leather passed horizontally round the chest, is the best of all methods of enabling the horse to apply his power in draught; but though this is now and then seen on dainty sets of harness, as a rule the great clumsy old choking collar is still in use amongst us. Except for our huge, slow, draught wagon horses, the collar has had some diminution in size and weight, though little in form or adaptation to the animal; but in the case of these elephantine horses conservatism still has quite its way, and the upper part of the collar is surmounted with a towering scutellated edifice in bull hide, of no earthly use except to the saddler's bill, and which adds to the waste of leather the waste of animal power in carrying a useless load for ever about. Nay, so strange is this tendency to stick by the old paths in this article of horse gear, that those who have been at Marseilles will have seen the draught horses there, and in other parts of Provence, with their collars surmounted by a huge, bent pointed, conical horn of leather stuffed, rising high above the topmost point of the collar itself, and arching forward over the horse's neck—a perfectly useless appendage, and one for which, on inquiry, no end or origin but habit is assigned, but which has probably been handed down and in use amongst these Provençals from the remote days when Pythæas and Euthymenes brought their horses from Magna Græcia and founded Marseilles itself.

Again, look at the frequent scene that is presented by a poor fallen horse upon the streets of our towns. With frantic efforts, and wrenching every joint and limb, the noble brute with little help (unless blows often given be such) may regain his feet, and resign his heaving flanks again patiently to the work in which he is to live and die. But as he frequently falls, netted and encumbered in the disarranged harness; and the latter, especially the traces, are so miserably adapted to this, though a daily condition of their use, that *they have to be cut* in order to permit of the liberation of the horse, and of his getting again on foot.

Fig. 1.

All this, and a great deal more, were we to devote our space to a dissertation in particulars of horse gear and harness, would be found to arise—in part from mere small tradesman's views of "making work," &c., but mainly from the fact, that all that relates to the horse, in his ordinary avocation and uses, is surrendered to the management of comparatively very ignorant, prejudiced, and unobservant men; men sharp-witted to a proverb, in all that relates to "the stable mind" perhaps, but men without any physiological, mechanical, or other culture, and who never dream of spontaneously attempting the consideration of whether the straps and tongues and buckles that they have been born and bred amongst, admit of or require any radical improvement.

At last, however, a genuine mechanic, Mr. Beverley Fenby, the inventor of the Adytic Lock, has come, by some extraordinary chance, to apply his singularly original inventive mind to one universal organ of horse gear, and has produced a completely new form of buckle, which appears to us to constitute a decisive advance. In this the loose "tongue," though it has here its equivalent, is wholly got rid of, and with it the danger arising from its action as a stabbing instrument, either to the animal or to those about him.

Fig. 2.

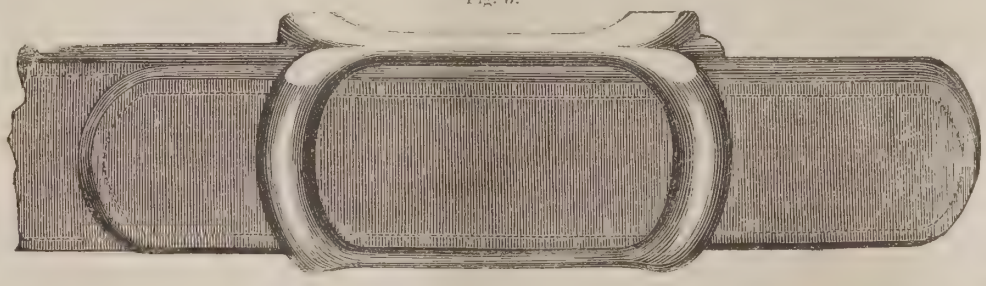
The buckle itself, as shown in fig. 1, consists of a single piece of metal, either malleable cast-iron plated or not, or of German silver. The opposite ends of the two straps which are to be united are each punched with one hole, or one or both of them may have several holes for adjustment as to length.

The two ends are passed through the opposite rectangular-shaped jaws or recesses of the buckle—one first, the stud upon its side and at one end being passed through the hole in that strap; then the other strap end, flat upon the former, is passed through the other end of the buckle, brought in over the other stud at its hole, and, finally, the two extreme ends of the straps are slipped in over each other, into the recesses of the ends of the buckle which they now completely fill by

the double thickness of strap; and the whole is secured together, as seen in fig. 2, and more at large in fig. 3. To disconnect the buckle and straps, it is not necessary, as in the case of the ordinary buckle, to drag back (or tighten) the strap, in order to get out the tongue before the strap can be disconnected. It is only necessary simply to slip out the extremity of either end of the strap from the recess in the buckle. The other strap is then free in the recess, by the thickness (equal to its own) of the strap end so taken out; it at once and without effort can be slipped off the buckle *stud*, and then all is loose.

For numerous purposes in relation to harness and other strap adaptations, this facility of almost instant and easy detachment is valuable, but for none more so than when applied to traces. When the horse falls so that his weight lies upon one of the ordinary traces in use, it is almost impossible to get the latter disconnected, either from the horse or the carriage. The animal must be lifted bodily if the strain upon the trace caused by his weight is to be relieved for the moment, so as to unbuckle the ordinary tongue buckle, even if this lubberly and clumsy and usually rusty affair of the trace size will admit of that even then. With Mr. Fenby's buckle, the trace, no matter how great be the strain existing upon it, is without muscular effort in a moment separable.

Fig. 3.

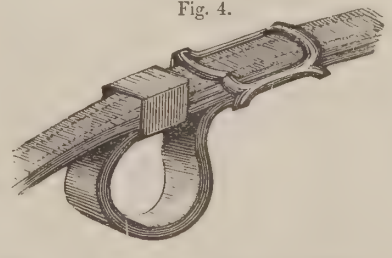


For shaft tugs also (for single harness in shafts) this buckle has the great advantage that the tilting upward of the shafts against the top side of the loop of the tug does not tend to disarrange the buckle in any way; nor is there any sharp tongue to protrude dangerously as in the ordinary buckle by such action through the strap for its whole length.

There is no bending of the leather at the buckle; and as such sharp turns are avoided, so is the rapid wear and rotting of the leather as experienced at such points. The pull of the strap is direct against the buckle studs in the centre of the width. There is no back play; the buckle and the strap ends, once laid together, being one rigid whole for the time being. Moreover, these buckles being capable of ready and complete separation and restoration rapidly from and to the straight leather straps, both can be more readily and perfectly cleaned. Their appearance, as we have seen them made in German silver, is extremely neat and good.

There is but one point in which these do not supply all the conditions of the common buckle. The latter fulfils in use the function of a sort of "loose pulley," by which the strap for certain purposes, such as that for a portmanteau, can be drawn "taut" before slipping in the tongue. Possibly, however, Mr. Fenby's ingenuity may hereafter enable him to superadd this power either in this or another form of buckle. If he can do this, and finally make *a buckle that shall lock* with some sort of key, so as to give an additional security to leather bags and portmanteaus, he will add much to the achievement he has already performed.

Fig. 4.



At present there are very few persons habituated to travel much upon our own railways, and who are accustomed to intrust valuable-looking portmanteaus to the luggage vans, but must have experienced the suspicious and unpleasant fact of finding the straps loose, or altered in some way, between the delivery into the guard's van and the turning out of it to the owner upon a short stage platform.

We have ourselves more than once found this, and could come to no other conclusion but that all railway guards were not immaculate, and that such things as false keys for portmanteaus might probably exist as "van tools." Well, two straps over all and buckles, each of which would in some simple way lock, would add much to the security of the portmanteaus, as well as secure the straps themselves, which, when detachable, are frequently stolen off, in travelling abroad especially, and by "four wheeler" cabmen on night jobs from the railways in London.

Mr. Thos. W. Jones, saddler's ironmonger, of Birmingham, is, we understand, manufacturing Mr. Fenby's buckles.—Ed.

SCHOLL'S PLATINUM GASLIGHT PERFECTER.

Mr. John Scholl, of Berwick Street, Soho, has lately brought out a cheap and useful article which he calls the "Gaslight Perfecter," the placing of which over an ordinary fish-tail or other gas burner increases the brilliancy of the light to an extraordinary extent. As adapted for fish-tail and bat's-wing burners, the perfecter consists of a short brass tube or cap, which is split in order to enable it to grip the exterior of the burner when applied, and diametrically across one end of this tube there is secured a thin strip of platinum, placed edgewise. This cap is to be placed upon the burner so that the lower edge of the platinum strip may rest close upon the top of it, and, in the case of a fish-tail burner, exactly between the holes, so that it may be in the middle of the flame lengthwise. In the case of a bat-wing burner, the strip should be parallel with but not immediately over the slit; and when an argand burner is used, the strip is made of an annular form, and provided with spring clips to fit the inside of the burner. The annular strip of platinum should be so adjusted as to conform to the series of holes, and be situate just sufficiently to one side thereof as not to actually impede or obstruct the exit of the gas. From experiments we have made on an ordinary fish-tail burner, consuming 2½ feet of gas per hour, and giving the light of six candles, we find that the addition of the perfecter to the same burner increases the light obtained to nine candles. An important saving in gas is thus obtained, and, in addition, the perfecter causes the whole of the gas to be consumed; hence all unpleasant smell and the whistling from unequal pressure is prevented. We have no hesitation in recommending the "Gaslight Perfecter" to the notice of all gas consumers.

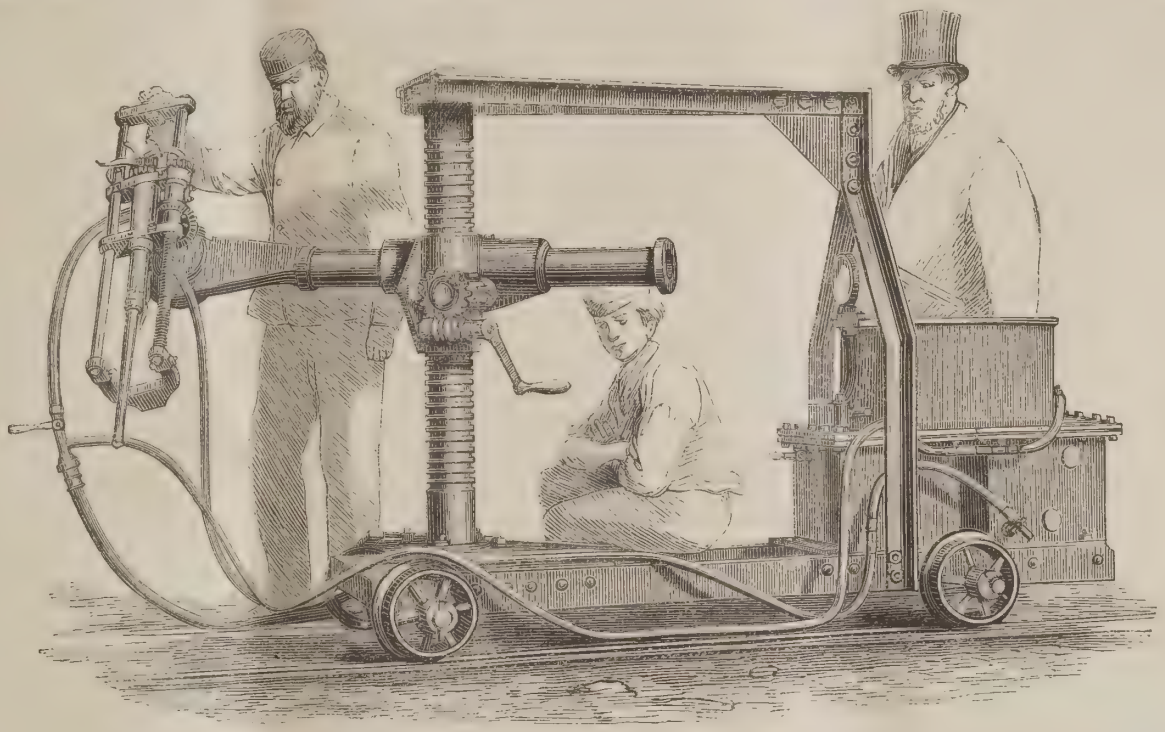
DŒRING & SACH'S TUNNELLING MACHINE.

The annexed woodcut represents a perspective view of a tunnelling or boring machine which has been recently introduced into this country by the inventors, Messrs. Dœring & Sach, who are represented in London by Mr. J. W. Groose, C.E., of 30 Duke Street, Westminster.

Compressed air is the medium employed in working this machine, the piston rod of the compressed-air cylinder being provided with a socket for carrying the boring tool. The piston rod works through a bush on the front end of the cylinder, and from the opposite end of the piston another, but smaller rod, connected with a cross-head, passes through the opposite end of the cylinder. A key or feather is formed or fitted upon the smaller rod, which works through a corresponding keyway in a bush on the rear end of the cylinder. By imparting a rotatory motion to this bush, the same motion will obviously be transmitted to the smaller rod, and to the piston and boring tool. Suitable brackets are cast on the cylinder, which slide along parallel guide-bars, supported by a wrought-iron cradle, which serves to connect them to the main supporting standard of the machine. A screw thread is formed upon one of these guide bars, upon which, and between the cylinder brackets, works a long nut carrying a bevel wheel, in gear with a second bevel wheel fast on the spindle of a crank handle, whereby the position of the machine on the guide bars can be readily adjusted by hand, or withdrawn, if required, for the purpose of changing the drill or commencing a fresh hole. In two holes made in the cross-head before-mentioned work the curved ends of a pair of levers, keyed upon a rocking shaft carried by brackets attached to the cover of the cylinder valve, such rocking shaft also carrying three short levers, respectively fixed at the centre and opposite ends thereof. One of these levers

serves to work the slide valve, whilst the other two, through the intervention of pawls and ratchet wheels, impart the rotatory and feed-up motion to the tool. The main standard or support of the machine is carried on four wheels running on rails, and is provided with an upright column, having a number of annular grooves cut therein, so as to form a species of cylindrical rack. A socket slides along this column and carries a worm, actuated by a crank handle and gearing into a worm wheel on the axis of a pinion, which is in gear with the teeth of the rack, hence the height of the socket on the column can be adjusted with facility.

A second socket, at right angles to the first, is formed in one piece therewith, and has an arm working horizontally therein, which arm is jointed at its extremity to the boring machine above described. Facility is thus afforded for working the machine at any angle, or in any required direction. The air pressure employed is from 20 to 25 lbs. per square inch, supplied from a reservoir by flexible pipes, giving as a general working speed from 250 to 350 strokes per minute. A jet of water, obtained from tanks carried at the back by the main framing, is caused to play upon the tool whilst in action, by which means the *débris* is cleared away. When at work, the frame is fixed by means of wedges against the roof of the adit, so as to hold the entire machine dead fast for the time being. The arrangement of these tanks is peculiar, and is as follows:—Two tanks are placed side by side, and are surmounted by a third one, which is open, and kept supplied with water. A cock is fitted near to the bottom of each of the two lower tanks, such cocks communicating with the water-jet pipe; another cock is fitted near the upper portion of the tanks, communicating with a branch from the compressed-air supply pipe. Both the lower tanks are further provided with cocks near the top, the one communicating with the atmosphere, and the other with the upper tank. The following is the mode of using these tanks:—Supposing the lower tanks to be empty, and the upper one full of water, and all the cocks closed; the air cock, and that which connects the upper and lower tanks, must be first opened, so as to allow the water to flow into and fill the lower tanks. These cocks should then be closed, and the cocks which serve to connect one of the tanks with the compressed-air and jet pipes opened,



whereupon the pressure of the air will force out the water through the jet pipe. So soon as one tank is empty, its cocks are closed; and the adjoining tank is similarly placed in communication with the compressed-air and jet pipe whilst the other is filling.

We understand that Messrs. Dœring & Sach's boring machinery has been in successful operation for some time at the zinc mines of the Société de la Vieille Montagne at Moresnet, near Aix-la-Chapelle, and also at some mines in Prussia. The saving effected by this machine, both as regards labour, repairs of tools, and consumption of blasting powder, is considerable. The saving in the last-mentioned item is due to the great facility afforded by the machine for driving the holes deeper and in better positions than can be accomplished by manual labour.

As regards speed and economy of labour, it has been proved from actual trials that, whereas 8 metres were driven in one month by the machine, at a total cost per metre of 120 francs 66 cents, only 3 metres could be driven in the same period by manual labour on the same ground, at a cost of 194 francs 88 cents per metre.

ON THE FLOW THROUGH APERTURES OF SOLID BODIES.

(*Continued from page* 364, *Vol. II., Third Series.*)

Observation upon the Symmetry of the Transformations.

In the phenomena which it is proposed to investigate, all are symmetrical with respect to the line which is at the same time the axis of the cylinder formed by the block, as well as the axis of the cylinder formed by the jet.

It results, *a priori*, from this arrangement, that all the actions and deformations must be symmetrical with respect to this axis; and it immediately follows from this observation, that in place of studying those which may pass for all the generatrices of a cylinder concentric with the axis, it will suffice to examine how a single one of the generatrices of this cylinder will transform itself—that which passes through the point M, for example.

For the same reason of symmetry, the deformations of the horizontal section which may pass through the same point M, will be perfectly characteristic, provided the deformations of a radius passing through that point are observed.

Each one of the deformations thus becomes reduced to a question in plane geometry, the enunciation of which is more easily formularized.

At first, then, the deformation of one of the generatrices of the central cylinder will be considered; secondly, the generatrice of the point M, both in the block as well as in the jet; lastly, the transformation of a radius which passes through the same point M, also in the block as well as in the jet.

Of a Transformed Generatrice of the Original Central Cylinder.

The three equations which serve for the present are those previously numbered (1), (3), (4).

The first, differentiated with respect to h and l, gives successively

$$R^2 h = R^2 H - R_1^2 l,$$
$$R^2 d h = (R_1^2 d l),$$

and dividing member by member,

$$\frac{d\,h}{h} = \frac{d\,l}{l - \frac{R^2}{R_1^2}\,H},$$

the equation (3) is

$$\frac{d\,h}{h} = \frac{2\,R_1\,d\,R_1}{R^2 - R_1^2},$$

where, in replacing $d\,R_1$ by its value in $d\,r$, deduced from equation (4),

$$-\frac{d\,h}{h} = \frac{2\,R_1^2}{R^2 - R_1^2} \quad \frac{d\,r}{r} = \frac{d\,l}{l - \frac{R^2}{R_1^2}\,H}.$$

This relation between r and l gives immediately by integration,

$$\frac{2\,R_1^2}{R^2 - R_1^2}\,\text{log. hyp. } r = \text{log. hyp.}\left(l - \frac{R^2}{R_1^2}\right) + C.$$

Since it is desired to apply this relation to a generatrice of the original central cylinder, for which we have at once $r = R_1$, $l = 0$, we shall have to determine the constant C—

$$\frac{2\,R_1^2}{R^2 - R_1^2}\,\text{log. } R_1 = \text{log.}\left(-\frac{R^2}{R_1^2}\,H\right) + C,$$

and, consequently,

$$\frac{2\,R_1^2}{R^2 - R_1^2}\,\text{log.}\,\frac{r}{R_1} = \text{log.}\,\frac{l - \frac{R^2}{R_1^2}\,H}{-\frac{R^2}{R_1^2}\,H}.$$

We place this relation under the exponential form, in remarking that r and l are nothing else than the co-ordinates x and y, such as they have been defined to be; this gives for the equation of the transformation—

$$\frac{y - \frac{R^2}{R_1^2}\,H.}{\frac{-R^2H}{R_1^2}} = \left(\frac{x}{R_1}\right)^{\frac{2\,R_1^2}{R^2 - R_1^2}},$$

whence

$$y = \frac{R^2H}{R_1^2}\left[1 - \left(\frac{x}{R_1}\right)^{\frac{2\,R_1^2}{R^2 - R_1^2}}\right] \quad . \quad . \quad . \quad (6).$$

It is seen at once that the abscissa x can be nothing, since $y = \frac{R^2}{R_1^2}\,H$, that is to say, when the block is entirely exhausted, and when the material which originally composed it shall have been expended to form the jet.

The value of x, moreover, diminishing in proportion as y increases, since $x = R_1$, which corresponds to $y = 0$; since $x = 0$ for the complete exhaustion of the block, it is recognised that the first observations are proved thus correct by the calculus.

It will be seen ulteriorly how equation (6) has been enabled to be compared with the result of an experiment that has been specially made with the distinct purpose of verifying it.

If it had been desired to limit this part of the investigation with a simple recognition of the modification of the original generatrice in the block, it would have sufficed to stop at the relation—

$$\frac{d\,h}{h} = \frac{2\,R_1^2}{R^2 - R_1^2}\,\frac{d\,r}{r} \qquad \text{above;}$$

which gives at once, and by the same means—

$$\frac{h}{H} = \left(\frac{r}{R_1}\right)^{\frac{2\,R_1^2}{R^2 - R_1^2}},$$

and

$$r = R_1\left(\frac{h}{H}\right)^{\frac{R^2 - R_1^2}{2\,R_1^2}} \quad . \quad . \quad . \quad (7).$$

The original generatrice is itself simply brought near the axis at a distance r, and the original central cylinder forms, in the block, a surface of revolution having a rectilinear meridian, parallel to a meridian of the original cylinder; that is to say, in other words, that the original cylinder becomes altered, by the treatment, into another cylinder concentric with it, and, therefore, the meridional line of the original cylinder becomes thrown out of its former plane, being either advanced further forwards, or retrograding.

(To be continued.)

COAL-CUTTING MACHINERY.

One distinct evidence of the rapid advance that this promising attempt to substitute motor and machine power for crude human hand labour, is afforded in the fact that one of the most intelligent and powerful associations of coal owners in Great Britain have now issued the following circular, inviting the competitive struggles of the mechanical engineers of all the world, to produce the best coal-cutting machine.

The following are the conditions laid down for the competition:— The members of the South Lancashire and Cheshire Coal Association have determined on inviting competition for the best coal-cutting machine, and the committee or referees appointed by the Association have issued the following regulations for the guidance of competitors:— 1. That compressed air is the proper motive power for working coal-cutting machinery. Machinery for compressing air is already erected at several collieries in the neighbourhood of Wigan, and will be placed at the service of competitors. 2. Inventors taking a prize must be bound by the condition that no annual payment, or tonnage royalty, as patent right, shall be charged to any present or future member of the above Association, but that such member shall pay a patent right on the purchase of each machine, to include the working thereof, which patent right shall in no case exceed fifty per cent. of the cost of the machine. 3. The committee reserve power not to award any premium unless they are satisfied with the performance and capabilities of the machine or machines submitted for trial. 4. Machines furnished for trial by November 1, 1867, will be tried by the committee, who will make their award thereupon in or before the month of May, 1868. 5. The committee direct the attention of competitors to the following requirements to which the machine must be adapted:— Thickness of seams, from 2 feet to 9 feet; dip, or inclination, from horizontal to an angle of 20 degrees; as to weight of machine, lightness and easiness of movement desirable; maximum size of tub or waggon used in the mines, 3 feet 6 inches by 3 feet, and 3 feet in height; gauge of road, from 1 foot 6 inches to 2 feet 3 inches.

Two circumstances connected with this are, we think, matter for regret, and may possibly disadvantage the otherwise probably greater value of the results hoped for.

It seems unwise to lay down any restriction as to the nature of the prime motor to be employed. Why should compressed air *alone* be admissible? Might not some ingenious inventor prove that gases somehow evolved under pressure; or work transmittted by some method from a distance, as by M. Hirn's telodynamic mode, described in our last part; or the slow burning of gun cotton in close vessels; or something else that no one as yet has any notion of—prove as good or even better than compressed air?

Again, it seems unwise to encumber the competition with any conditions as to patent, royalty, or price, &c.; all that would adjust itself as soon as the *really best* coal-cutter is ascertained. The prizes, we have heard, though not upon authority, will be of £400, £300, and £200.—Ed.

THE CHANNEL RAILWAY CONNECTING ENGLAND AND FRANCE.

By James Chalmers, Inventor of the Chalmers' Target.

That Mr. Chalmers, though not regularly educated as an engineer, is by nature a mechanic admits of little doubt, since the trial of his target at Shoeburyness; and we therefore fully admit the legitimacy of the appeal he makes in his preface to the second edition of the volume which describes his project for crossing at the bottom of the Straits of Dover, against those who would condemn the project unheard because the author is not "a regular practitioner." The appeal, however, was needless as respects all those competent to form a judgment as to the details of Mr. Chalmers' plan, for these will judge it upon its own merits, not upon the antecedents of its author; well knowing, as all really competent engineers do, that there are plenty of "regular practitioners"

in every profession, engineering included, who are dunces, and some outsiders as good as the best within the fold.

In brief stated, Mr. Chalmers' plan for forming a double tunnel beneath the waters, but upon the bottom of the channel, consists—Throwing down first a flat bed of gravel and like heavy, strong material to give a uniformly sloped top table or surface a few feet above the natural bottom; to construct strong, cylindrical iron tubes of diameter sufficient to enable a single line to pass through inside, these to be in lengths of 300 to 400 feet each, formed with rings of double T iron outside, upon which an outer skin of staves of timber is bolted, leaving a hollow space between. He proposes to sink such tubes one after the other in continuous double line from shore to shore, and having connected all their adjacent ends by water-tight joints, to line the whole length with a cylinder of brickwork, and then to cover over the outside with such a continuous under-water mound or bank of gravel and stone, &c., as shall prevent any further disturbance of the tubes. In the centre of the length there is to be a large cylindrical brick and iron tower, or ventilating shaft, connecting with both lines of tubes, rising high above the water surface, and carrying lighthouses on its summit.

The line he projects is from a point on the English coast about midway between Deal and Folkestone, and on the French coast about midway between Sangatte and Wissant, reaching into shore cliffs of chalk at both ends.

Mr. Chalmers enters into particulars, illustrated by lithographic plates, as to how he proposes to float, bring to site, and sink into place his proposed tubes in succession; and describes with some minuteness how he proposes to bring the ends together, get them fairly opposite each other at every 400 feet of the long way across, and afterwards staunch each junction so as permanently to keep the water out. He gives us his estimate at £12,000,000; and he goes into the question of the probable durability of the ⅝-inch plate iron tubes, coming to the conclusion that before these were wholly decayed, which he seems to think they would be in forty or fifty years, "the embankment would have become filled up into a solid mass, and the concrete, the timber casing, and the brick lining alone would insure permanency."

As to the general *possibility* of what Mr. Chalmers proposes, we would be disposed at once to concede it. We deem the construction proposed for his tubes decidedly faulty; the outside timber seems a mistake. A double-cased iron cylinder with a hollow produced by a succession of annular belts of T iron between the inner and outer skins would be better, cheaper, stronger, and more manageable, and could remain actually water free, which would be absolutely impracticable as regards the hollow spaces within his timber shell, "caulk he never so wisely." Moreover, this foot thick shell of timber would, in contact with sea water and calcareous mud, or concrete, to say nothing of *Limnoria terebrans*, rapidly decay, and provide the secure means of disturbance for his embankment in which it would be inclosed. Again, while we are compelled to hesitate as to the practicability of the precise details by which he proposes to unite, watertight (under a maximum head of 168 feet), the ends of his tubes; and still more to doubt that he has described any sufficient method for getting them fairly opposite to each other when landed on the bottom; still we are prepared to concede fully the mechanical possibility of effecting both these objects, and effecting them without greater risk or much more difficulty than must always attach to dealing with very large floating masses, and then working in very deep water—water so deep, indeed, that at its greatest depth diving operations are quite problematical: five atmospheres being a pressure as to the effects of which upon the human lungs, and economy generally, we have as yet no experience; to say nothing of practical difficulties in diving tackle, either for bell or helmet, at a vertical stretch of 170 feet below the water surface. In a word, given the money and time, we admit the practicability of finding the means for doing generally what Mr. Chalmers has projected, though not by the means in detail which he has described, and which, were he about actually to proceed, he would no doubt soon see reason to modify in many respects. We may go further, and will admit the decisive advantage that his scheme, generally, presents as compared with any project for excavating a tunnel, at whatever depth below the bottom of the channel, or however proposed being excavated, namely, that *no overwhelming disaster* is possible with a well-devised submerged-tube scheme; whereas the chance of utter and irremediable destruction, at any stage of its construction, is a contingency that must beset every plan for a tunnel excavated in the chalk or other material of the sea bottom. Such a tunnel might be completed for the whole 19½ miles of its entire length, and nineteen-twentieths of the whole capital have been spent, and yet, in the still remaining block of stuff of half a mile remaining to be taken out, a natural breach of continuity might be encountered sufficient to set at nought all attempts to command the inrush of water that might be encountered.

It may be said, and probably will be advanced, should Mr. Hawkshaw or others bring the excavated tunnel forward as an actually advisable work, that, as soon as dubious ground is encountered, *shields* may be employed, and a rush of water thus rendered impossible. We believe a shield under a pressure of 400 or 500 feet head of water, for something like *that* will be the maximum head inevitable to a deep *under-bottom* tunnel, is an absolute impracticability; and that, should a heavy water seam or tube be anywhere encountered by the tunnel on the line across, it will give no notice of its being neared until it suddenly would blow away the face of the heading and fill the work up. The very essence of the excavated tunnel scheme rests upon the assumption that, by going deep enough into the earth beneath the bed of the channel, so large a mass of material shall be interposed between the sea and the perforation that a completely water-tight barrier shall exist overhead the whole way across.

There is much plausibility in the arguments by which this may be supported. It may be said, and at least without the possibility of contradiction as a matter of fact, because ascertainment is impossible, that no matter how absolutely broken up and discontinuous, or of whatsoever nature (unless boulder clean gravel, which probably does not exist) may be the material of the bottom of the channel, if we can only interpose some 300 or 400 feet thick of it between the sea and the tunnel the waters must be kept back, at least from any very serious inrush. But, granting all that, it is far from improbable that at some one point *near* to the line, for it needs no more, or intersected by the tunnel, a tubular cavity, no matter how irregular, and perhaps not one-fourth of a square foot in area, may be encountered, and that from this a rush in of water may occur.

Should such take place, we confess we should look very hopelessly upon its being within the reach of human power at present to again lay dry the excavation, and command the leak, and if so, the work, however far advanced otherwise, becomes a total loss. Now, from this fatal sort of contingency Mr. Chalmers' scheme is pretty nearly free—free not only because his maximum water pressure is that of a head of some 170 feet against 300 or 500 feet, and therefore more controllable, but because every length of tube may, until the whole be completed, be kept safe from any inrush whatsoever at the joints, which are the only penetrable places, assuming the whole lengths themselves sufficiently resistant to pressure.

We are content to assume that Mr. Chalmers had been able to spread his level bench of gravel, or gravel professing to be concrete, extending right across from shore to shore, and with a width of only about 120 feet (as shown to scale on his drawings), rising at a minimum some 10 feet or so above the bottom of the channel. We pass by all consideration of how much extra stuff must be thrown in to meet the loss of available bulk by compression into the soft bottom (either now or at a subsequent stage), and by tidal drift and spreading, nor shall we inquire how far this and such like contingencies must affect his estimates. Nor shall we too curiously inquire how far it is practicable to deposit concrete through 180 feet—30 fathoms per admiralty chart—depth of sea water, in such a form after it has arrived at the bottom (even through a tube reaching the whole depth), as to be of much use as concrete when *in situ*.

We are ready further to assume that all difficulties as to the floating, mooring, sinking, depositing, and jointing the whole of the 270 or more lengths of tubes shall have been safely and fully accomplished, and that Mr. Chalmers is ready to cover them up with his outside encrusting bank of gravel and concrete. It will be admitted that we have not been hard to please or crotchety then, as to small difficulties—that we exercise thus a largely charitable and believing spirit. So far done, then we ask Mr. Chalmers does he suppose that his under water bank of about 120 feet wide on the base, by 40 feet in height to the crest, will stand up *in water* even for a day at a slope such as this, 1½ base to 1 vertical, even supposing the water to be absolutely still? We ask this whether the bank be of gravel, so-called concrete, or lumps of such stone as can be commanded at the site at any reasonable price? But the water in the channel is never still; it is that of a rapid tideway running at the rate of tidal stream of about 3 miles per hour, for about

six hours of every spring tide, and with strong and long-continued up or down channel gales having a still greater surface velocity, which extends to a depth at the least equal to the length of the largest channel waves, say 60 or 70 feet.

The result then of raising a bank of 40 feet in height above the bottom, right across this channel, a bank which for some miles at each shore end would be in height more than half the total depth of water, would be this: supposing the bank once completed at the slopes given, a formidable check would occur in virtue of this under water dam to the tidal stream, and the immediate effect would be to level down the bank, and reduce its slopes upon both sides to something like 5 to 1, in place of 1½ to 1, just as was the case with Plymouth breakwater and with Cherbourg, though of large, hard, and heavy blocks. The tidal wave coming in from the westward, would, no doubt, reduce the slope at the eastern side to something like 6 to 1; that coming in from the German ocean being of less power, might have its powers satisfied at possibly 4 to 1.

But it may be replied, admitting all this, it would be but a question of expense; it would only be to increase the cubic quantity of gravel, stone, &c., in the ratio of say 80 to 24, or to place, in Mr. Chalmers' estimate, 23½ million cubic feet of concrete, and 23½ million cubic yards of stone, in place of 7 millions of each of these. The increase would be startling in point of expense, but let that pass too; assume that the international value of the work will be such as to set no limits to expense, and let us suppose the tubes all safe and in place, bedded into the heart of the bank of gravel or so-called concrete and stone, of 40 feet in height, and with slopes of 5 to 1, averaging at both sides 400 feet base at the deepest part. Then we ask will it remain so? In our opinion it most certainly would not. To pass by further remark on the effects of tidal *stream* or wave current, the surface waves of the channel, as the travelled shingle proves, do by their undulatory sweep actually reach the bottom for some miles out from both the French and English shores, during all but very calm weather. Wherever there is a continuance of up and down channel storms, or that from distant storms to the east or west, a more than usually heavy sea sets into the English channel, the surface waves rise much higher, their sweep reaches much deeper, and as the astronomer royal has given good reasons for believing, their sweep actually reaches the bottom, probably across the entire channel, and with a bottom sweep whose velocity is probably in one direction (*i.e.*, that coincident with the tidal stream) not less than one-half the top or maximum velocity of the wave particle.

The result of placing then this 40 feet dam across the bottom would be to cause all the heavy waves to pitch over it with steep, breaker-like fronts, becoming, probably, on their eastern faces in heavy western gales, actual breakers, and at all times producing along the ridge what seamen call a "powerful ripple." But the waves suddenly checked in this way, on pitching over, must generate at each side a new set of reflected waves in the body of the water. These would sweep *down* the sloped faces of the under-water dam, and thence over the bottom beyond the toe of the bank, ultimately getting spent. The effect of this would be, at a by no means slow rate, to sweep out a deep trough of a hollow wave-like cross section, extending irregularly across the channel—the whole way across—at each side of the under-water dam, close along by, and parallel to, the toe of the slopes. The next effect would be the continual removal of stuff from the bank itself, and the occasional slippage of huge masses of the dam, by the weakening of its natural base, into these troughs. This must either be restored, or the tubes be in the end laid bare. But if restored the work will practically never end, for the new material must share the fate of old. But if we be right in our hydrodynamics, there would be little inducement before long to restore such sea ravages, for it is not conceivable that the sea bottom, thus disturbed at both sides of the bank and tubes, and dug out so as to leave these standing upon a low ridge, as it were between two deep hollows, should not soon begin to subside by compression, and to subside unequally. What then becomes of the continuity and of the staunchness of junction of the lengths of tubing? A change of level alone of 4 or 5 feet, even if extending in a pretty uniform curve between a dozen of these lengths, would be fatal to their capability of longer carrying the line with workable gradients there, even suppose, which is not possible, that the junctions remained water-tight.

We have thus very rapidly and imperfectly sketched the grounds upon which we have felt ourselves reluctantly obliged to come to the conclusion that, however ingenious in design, Mr. Chalmers' project is in fact impracticable, and that every other design which, like this, proposes to raise an under-water dam right across the channel, to a height occupying a large fraction of the total depth of the sea, shares with this the same character of ultimate impracticability.

We therefore come back to this, that (so far as anything has yet come from the brain of man) if a tunnel be to be made at all, the only feasible scheme is that of Mr. Hawkshaw—cut into the earth and burrow deep enough below the sea—and there is a reasonable chance that the work may prove possible to complete, and if once completed, nothing short of a geological convulsion would be likely to injure it. But on the other hand, should a difficulty occur it may, and probably would, prove as we have described, fatal, and the capital become wholly wasted. Perhaps in ten years or so hence, when speculation and money shall again get into a plethoric state, and when the lying and villany of the last two years or more shall have got rubbed a good deal out of memory, it may become possible by the help of the Overends and Gurneys of the future, to persuade the capitalists of Europe to risk some twenty millions upon this single throw of the dice, upon the *rouge et noir* table of vast projects.

But in the interim, and even after, if sober judgment be listened to, it seems to us that money and brain would be far better spent in forming two thoroughly good deep-water harbours, one at either side of the channel, and adapting those, so far as piers and basins, &c., &c., go, specially to the facile and rapid departure and reception of huge iron flat-bottomed steam ferrys, prepared to carry over the trains both ways, under cover, free almost from motion, free from delay or luggage examination, except at the points of starting and of arrival in England and Europe respectively.

Sooner or later we anticipate England and Ireland will be connected in a similar manner.—Ed.

THE CHASSEPOT BREECH-LOADER.

We translate from the pages of the *Propagation Industrielle* the following interesting description of the Chassepot breech-loader, which has recently attracted considerable notice in France.

Fig. 1 is an elevation of this breech-loader, the bolt being shown elevated to a vertical position, and the hammer cocked; and fig. 2 is a longitudinal vertical section of the arm, with the hammer in the position it assumes after firing, and the breech closed by the bolt, the handle of which assumes a horizontal position. The breech, *a*, is screwed on to the barrel; it is open on the upper surface, as well as on the right hand side, in order to allow of the working of the bolt, *g*. It is through this lateral opening that the cartidge is introduced. The rear face or end of the barrel serves as a stop to the front, *h*, of the bolt, *g*. The trigger mechanism, for holding the hammer when cocked, consists of two pieces, *c* and *d*, connected by a screw, *e*. The piece, *d*, tends always to project in the interior of the breech by the action of a spring, *b*, which forces upon the trigger the rear end of the piece, *c*, working on a centre at *f*. The pressure exerted upon the trigger is transmitted to the tumbler, *d*, which on being depressed releases the hammer and allows it to act under the influence of a balance spring and to strike the priming of the cartridge. The bolt, *g*, serves to open and close the chamber. It carries a piece, *h*, provided with a handle, *i*, for actuating it. Between the end of the bolt, *g*, and a shoulder formed on a movable head, *j*, there is fitted a washer of vulcanized india-rubber, composed of three superposed layers of different degrees of hardness. At the moment of igniting the charge the pressure exerted on the movable head, *j*, of the bolt is transmitted to the washer, which, being thus compressed, forms a perfect packing, and prevents the escape of gas. The portion which terminates the piece, *j*, is intended to form a space behind the cartridge for the expulsion and combustion of the fragments of paper which may remain in the barrel after the charge has been fired. The rear and upper part, as well as the left side of the bolt, *g*, are provided with two longitudinal slots of unequal size; the first acts as a safety notch, and the other forms the working notch. There is between the axle of these two grooves or slots a space of 90° when the breech is open. The cock or hammer is in front of the safety notch, so that if it accidentally becomes released no dangerous result will follow; it only corresponds with the working groove when the bolt closes the breech and is firmly held in its position by the handle, *i*, which will then be in a horizontal position. The bolt is also provided with a groove or notch opposed to the piece, *h*, the object of which is to permit, when charging,

of drawing the bolt back without it being stopped by the trigger piece. A second groove formed on the right hand side serves as a stop for the bolt, and prevents it leaving the breech when the screw, *r*, is in place. The hammer is composed of four parts, connected together with pins; these are, the hammer proper, *k*, the roller, *l*, the tumbler, *m*, and the spring bearing spindle, *n*. The gun is cocked, not, as hitherto, by causing the hammer to describe an arc of a circle, but by pulling it back longitudinally. The front part of this hammer terminates in an extended portion, *p*, which engages in the upper opening of the breech, and to the end of which is fixed the screw, *q*. It is this screw which, on penetrating one or other of the two grooves before referred to, brings the hammer into the safety notch, or permits it to strike the needle. The sliding of the hammer is facilitated by the roller, *r*.

The helical spring on the rod, *u*, is intended to give the impact of the needle on the priming, and has its bearing at *s*. The striking end of the needle is pointed, whilst the opposite end is fixed in a small holder, *t*. The following are the movements in using this arm, it being held in the left hand, with the butt pressed against the right side:—*First movement*—Place the forefinger against the trigger guard, and draw back the hammer with the thumb. *Second movement*—To open the arm, turn the lever from right to left, and draw back the bolt. *Third movement*—To load, seize the cartridge in the right hand, and insert it into the barrel through the opening made in the right side of the breech. *Fourth movement*—To close the arm, push the bolt forward, and turn the lever from right to left. *Fifth movement*—To fire, press upon the trigger. In order to place the arm upon the safety notch after the breech has been closed, the handle of the bolt must be elevated so that the smallest notch in the bolt shall be opposite the hammer, which must be followed up till its screw, *q*, arrives at the bottom of this notch. When it is desired to fire, it is simply necessary to turn the bolt to the side and draw the trigger.

On comparing this arm with the Prussian needle gun the great superiority of the Chassepot breech-loader will be evident. One great advantage consists in the mode of cocking, by simply drawing back a hammer, presenting a large and rough holding surface; whereas in the Prussian arm it is necessary to press against the end of a spring, situate at the rear end of the breech, and which frequently becomes clogged with dust, and consequently reduces considerably the rapidity of fire.

Fig 1

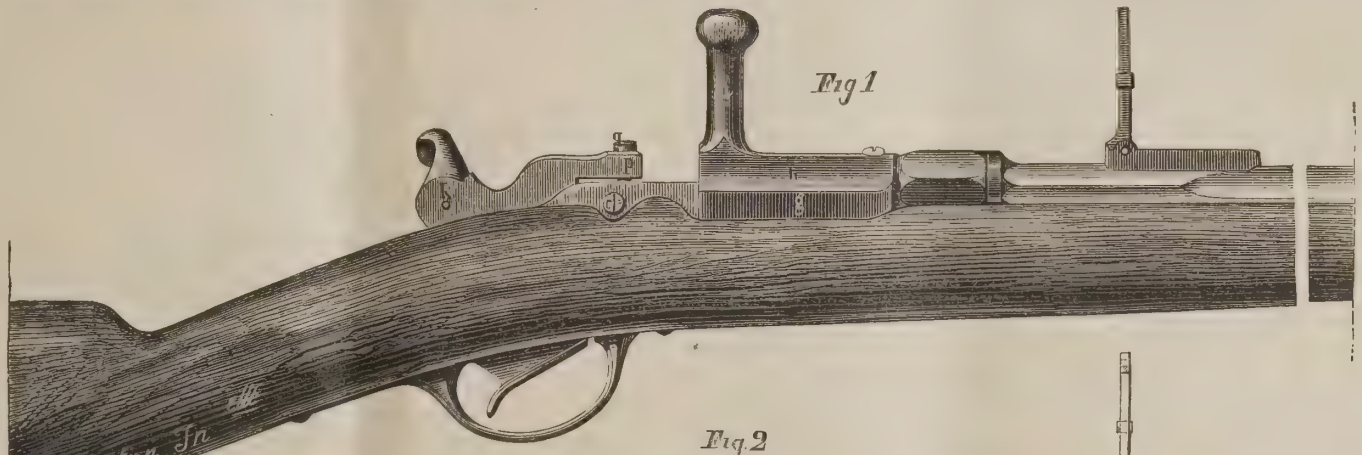


Fig 2

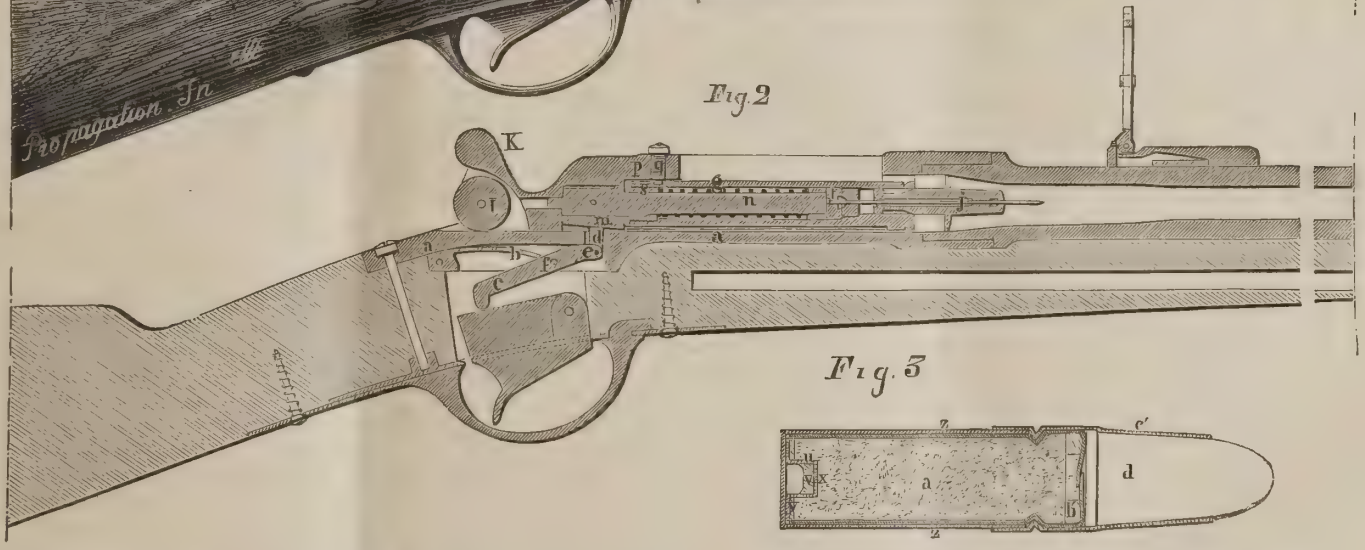


Fig 3

The objection of escape of gas at the breech is also avoided. Moreover, the needle when in action is always concealed within its sheath, from which it only protrudes at the moment of firing. This arm is rather shorter than the ordinary arm, and only weighs 3 kilogrammes. The barrel has a calibre of 11 millimetres, and is provided with four helicoidal grooves; owing to the absence of all loss of gas, these grooves retain their full effect: at 1000 metres, 50 balls out of 100 struck the target. With less accuracy the ball can be carried as far as 2000 metres. As regards speed of firing, this ranges from ten shots per minute in quick firing, to seven or eight shots with careful firing. It is to be observed that in the Chassepot arm this speed remains constant, whilst in the Prussian arm it rapidly diminishes; as many as fifty shots in four minutes have been made with the breech-loader.

The following is a description of the cartridge intended to be used with the Chassepot arm. Fig. 3 is a longitudinal section of the cartridge. It is composed of six elements, namely, the priming, powder case, powder, cardboard wad, ball case, and ball. The priming consists of a copper cap, *u*, similar to those used in the army, but rather smaller. It is perforated at the bottom with two holes, diametrically opposite to each other, and which are intended for the free passage of the flame. The fulminating powder, *v*, is placed at the bottom of the cap; a small wad, *x*, of cloth or wax covers it in order to preserve it from external shock. The cap thus prepared is fitted with a small washer, *y*, of thin tin; this washer is connected to a paper disc, intended to form the bottom of the cartridge when the priming will be complete. The powder case consists of a band of paper, *z*, rolled on a mandril, and cemented at the edges. When dry the priming is introduced by means of a special mandril, and after that it is cemented to the end of the case. This latter having been thus prepared, the charge of powder is introduced therein, equal to 5 grammes 5 decigrammes, which is slightly rammed to give rigidity to the cartridge. A wad of card, b^1, is placed on the powder, of 2 millimetres in thickness about, and having a perforation therein of about 6 millimetres in size, through which the ends of the case, *z*, are pressed; the excess of paper being removed with a pair of scissors. The ball case consists of a covering of paper, c^1, making two turns round a conical mandril, and cemented at the base only.

The ball, the form of which is shown in fig. 3, weighs 24 grammes 5 decigrammes. After having placed this ball in its case, the cartridge is completed by uniting the ball case to the powder case by a ligature in a groove made a short distance in the rear of the cardboard wad. As a final operation, the whole height of the cartridge corresponding to the ball, less the ogive or tapered end of the bullet, is to be greased, when the cartridge will be ready for use.

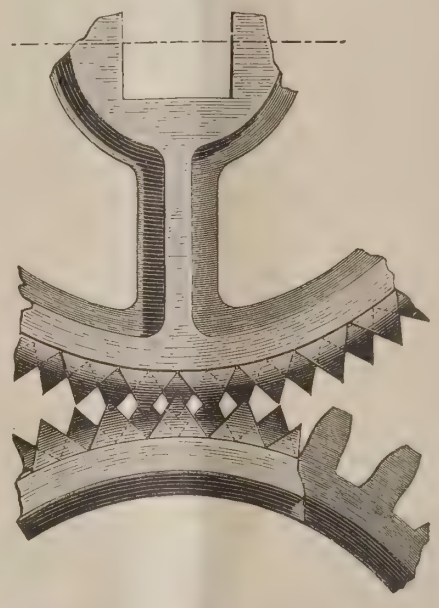
COAL-WASHING MACHINERY.

(*Illustrated by Plate* 1.)

At the present time, when men's minds are troubled with anxious forebodings as to the approximate exhaustion of our coal fields, it affords us pleasure to lay before our readers a description of a really practical mode of treating coal, with a view to the more economical employment of that valuable mineral. Mr. J. A. Birkbeck, of the Sheepbridge Coal and Iron Company (Limited), has recently turned his attention to the utilization of small refuse and other comparatively valueless coal, of which thousands of tons are now lying unproductive in our colliery districts, by subjecting it to a washing process by the aid of ingenious apparatus, by which means he effectually gets rid of all earthy matter, shale, and pyrites, and separates whatever proportion of available coal may be found mixed with the mass. This coal, when separated in the manner described below, is converted into a valuable coke, which is found to be admirably adapted for metallurgical purposes, and is, we believe, in considerable demand in Sheffield and the neighbourhood for steel melting. Before submitting the coal to the washing process, it is, when requisite, crushed and screened, in order to reduce it to fragments of nearly uniform size, capable of passing through a 1-inch or 1¼-inch mesh. The large coal thus treated is that which is picked out from the best coal when being loaded, and which has pieces of shale and pyrites adhering to it. Mr. Birkbeck also turns to account the coal mixed with dirt which the miner gets when "heading" or driving in the coal previous to the bank being formed. As the object of the miner is to get all the coal as large as possible, he "picks" or "holes" in the bank of dirt, but in doing so he also picks off a large proportion of good coal. In some collieries the miner riddles the coal, and throws the small or refuse coal back in the "goaf," where it remains as not sufficiently valuable to pay for the expense of raising it to the pit mouth. This also is now rendered commercially available by Mr. Birkbeck's mode of treatment, the small coal being subjected to the washing process direct, and the larger coal, as we before stated, to the preliminary crushing and screening operations. The coal to be treated having been assorted and collected into lots or parcels, each composed of fragments of nearly uniform size, is placed upon perforated plates, or false bottoms, contained in suitable washing vessels or tanks, and water is then forced up through the perforations in an intermittent stream, or in jets or pulsations, the result being the separation of the minerals according to their specific gravities; those of the highest specific gravities, such as stones and pyrites, being deposited upon the perforated false bottom, whilst those of lower specific gravity, namely, the coal, will be found deposited on the upper part of the layer, or will partly float on the surface, and be removed by rakes or other contrivances. The intermittent streams, jets, or pulsations of the water are obtained by the aid of a double-acting displacer or pump, or by the aid of a head of water regulated by means of cocks or valves.

Fig. 1 of our plate engravings represents a longitudinal vertical section of the general arrangement of the coal-washing works, with crushing and screening apparatus complete; and fig. 2 is a section taken at right angles to fig. 1. The rest of the figs. are enlarged details of the crushers and washing vessels, which will be presently referred to. In treating the larger-sized refuse coal, the rough coal as it is delivered is shot into a hopper, *a*, provided with a self-acting delivery door or slide, which allows it to descend at regular intervals into the well of an elevator, *b*, consisting of an endless chain of buckets, or an archimedean screw driven by any prime mover. This elevator delivers the coal into an inclined spout, whence it falls into an inclined revolving cylindrical screen, *c*; this screen should be perforated with round or square holes, in lieu of being composed, as is usual, of bars or grids, as the fragments of coal will be thereby obtained of a more nearly uniform size. The fragments which fall through the perforations are received on to inclined planes or shoots, which deliver them to the washing vessels, A A. Those portions of the coal which are too large to pass through the perforations of the screen are delivered at the lower mouth or end, and fall on to inclined shoots which convey them to the feeding hopper of a pair of crushing rolls, B, shown also in enlarged detail at figs. 3 and 4. These crushers consist of a pair of rolls, *d*, composed of a series of rings or discs having pyramidal teeth or projections cast thereon, as shown more clearly in the wood-cut, fig. 1, the several discs being strung on to a square shaft, so as to form a cylinder or roll. One of these rolls works in stationary bearings in the framing of the crusher, whilst the other is

Fig. 1.



capable of yielding more or less, to allow of the passage of any extra hard substance between them. It is kept up to its work by the action of the weighted lever, *e*, its bearings being allowed to slide between the fixed guide bars, *f*, bolted to the top of the framing. A distance piece, *g*, is introduced between the bearings of the two crushing rolls, in order to keep them at the proper distance asunder; in practice it is found that a clearance of about ¼ of an inch answers the best. These rolls are also driven from the engine of the works, and the crushed material falls on to an inclined spout which conveys it back to the well of the elevator, to be again elevated and passed through the screen as before. The washing vessels or tanks, A A, shown also in enlarged detail at figs. 5 and 6, are constructed of cast or wrought iron, supported by preference on standards or frames of sufficient height to allow of the passage of a truck or waggon underneath the vessels. They may be of a rectangular or other shape, and their sides at the lower portion should be inclined inwards, so as to form a species of hopper, A′, the opening in which is provided with a sliding door, C, capable of being readily opened or closed by a lever, D, or other convenient mechanical contrivance. Towards the upper portion of the washing vessels there is provided a false bottom, E, composed of one or a series of perforated plates or gratings, upon which the substance to be washed is placed, or allowed to fall from the screens. This false bottom is represented as stationary, but in some cases, as we shall presently describe, it may be made movable, so as to be capable of being raised to the top of the vessel, with a view to the ready removal of the deposit therefrom. F F are the pipes which supply the water to the washing vessels at a point below the false bottom. The front edge of each vessel is rather lower than the other edges, and to it there is fitted a spout, G, for conveying the washed material or substances to waggons or other receptacles. H is a cylinder situate at the back of and between the washing vessels, within which works a piston, I, the piston rod passing through a stuffing box in the top cover of the cylinder. A vertical reciprocating motion is imparted to this piston by a crank driven from the main shaft of the prime mover, for the purpose of imparting the pulsations to the water in the washing vessels. K K are pipes or passages which form communications respectively between the upper part of the cylinder and one of the vessels, and the lower part of the cylinder and the other vessel. When the vessels and cylinder are filled or partially filled with water,

Fig. 2.

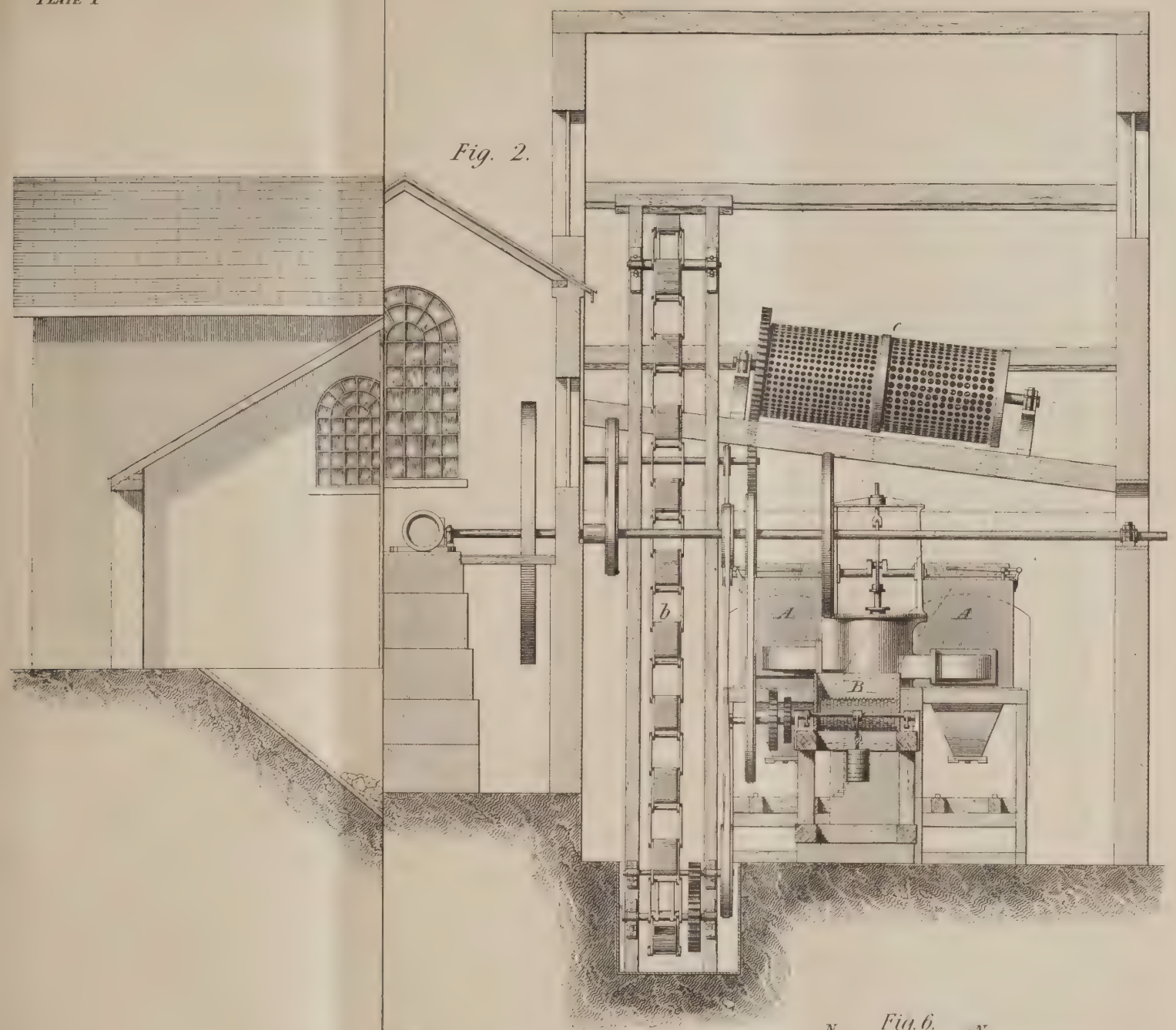
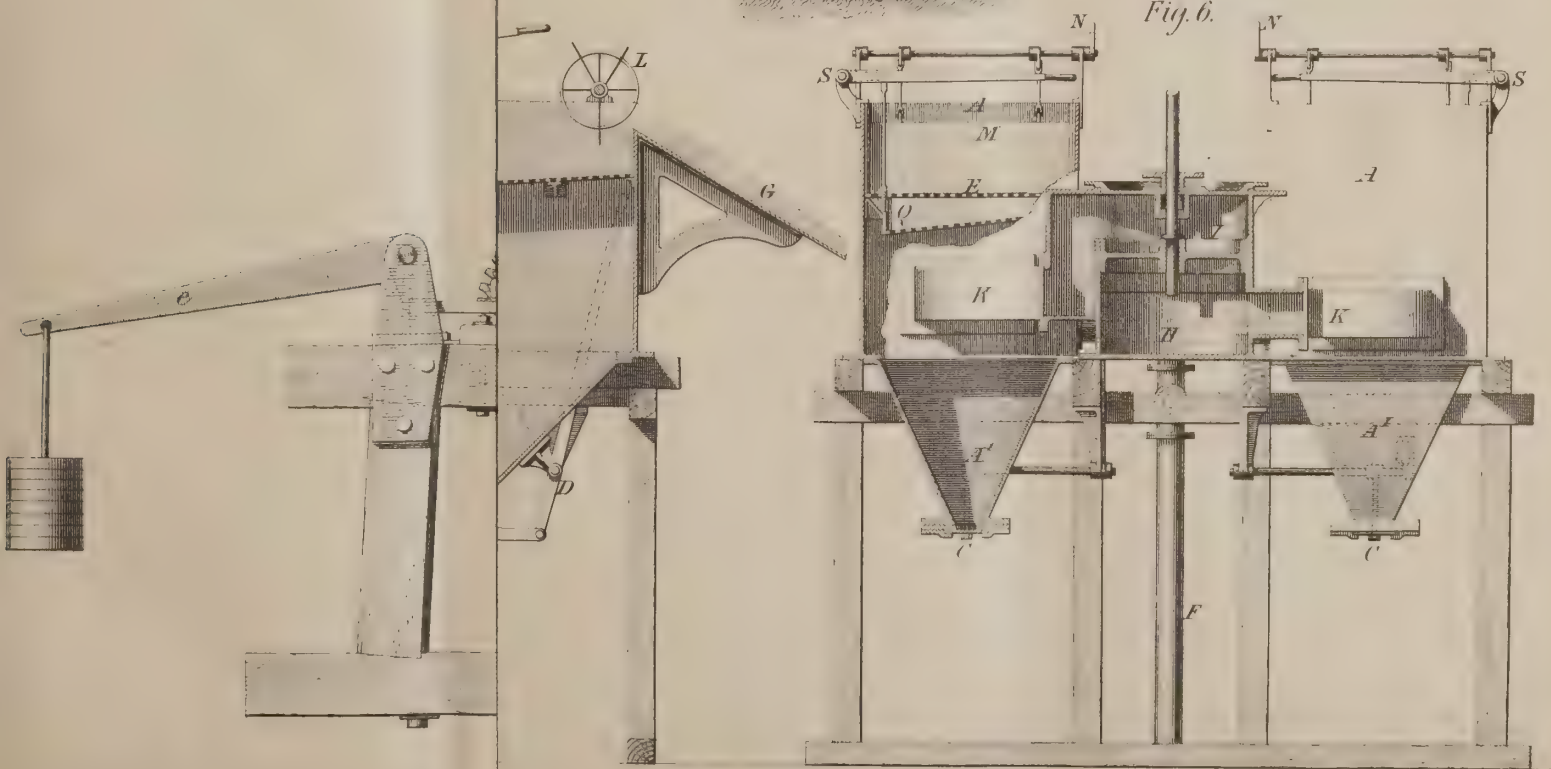


Fig. 6.



Patent Offices 47, Lincoln's Inn Fields, London.

Scale for Figs. 5 & 6 ⅓ in.=1 Ft.

COAL WASHING MACHINERY.

J. A. BIRKBECK.
SHEEPBRIDGE IRON WORKS, CHESTERFIELD.
ENGINEER & PATENTEE.

Fig. 1.

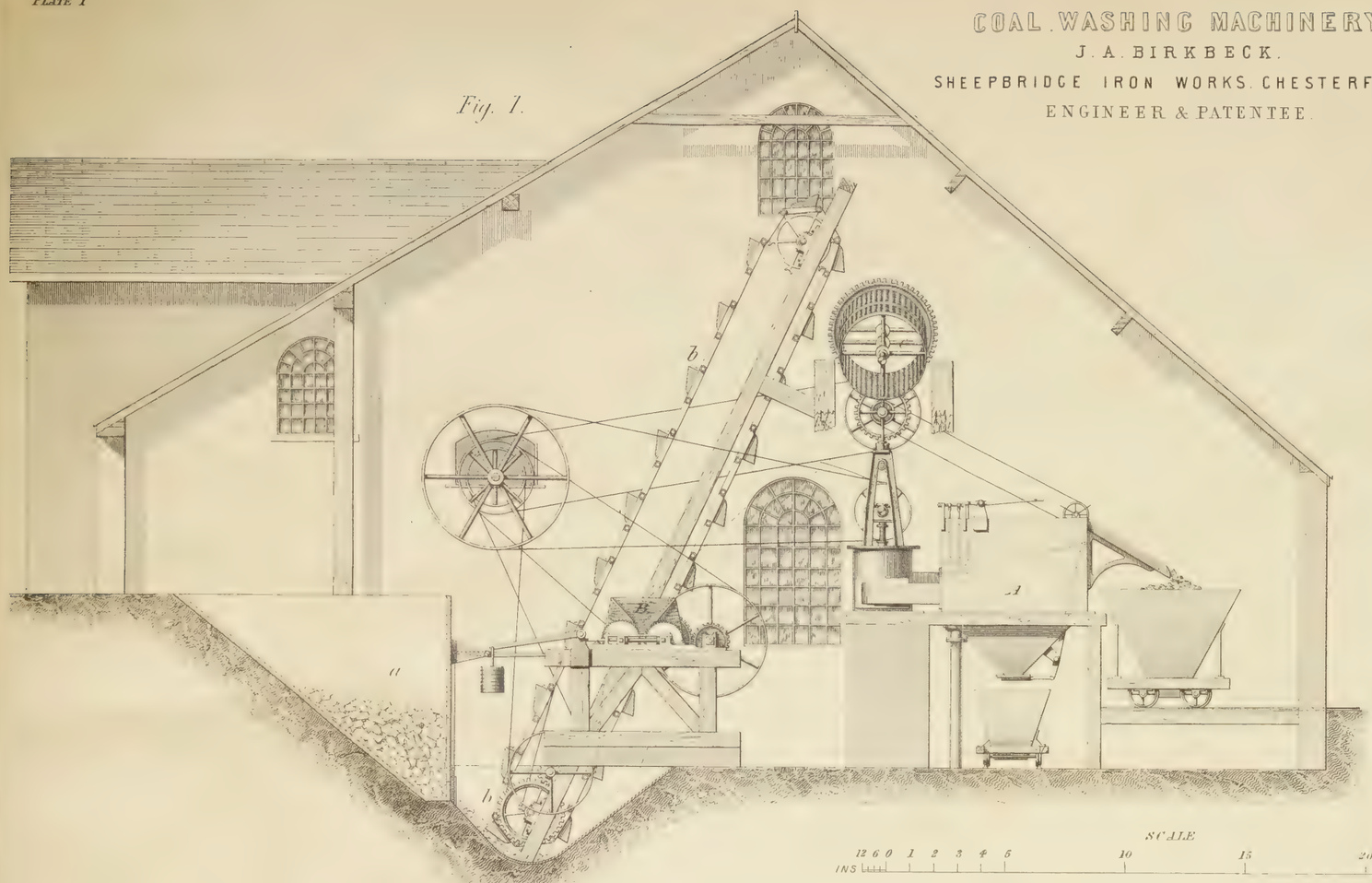


Fig. 2.

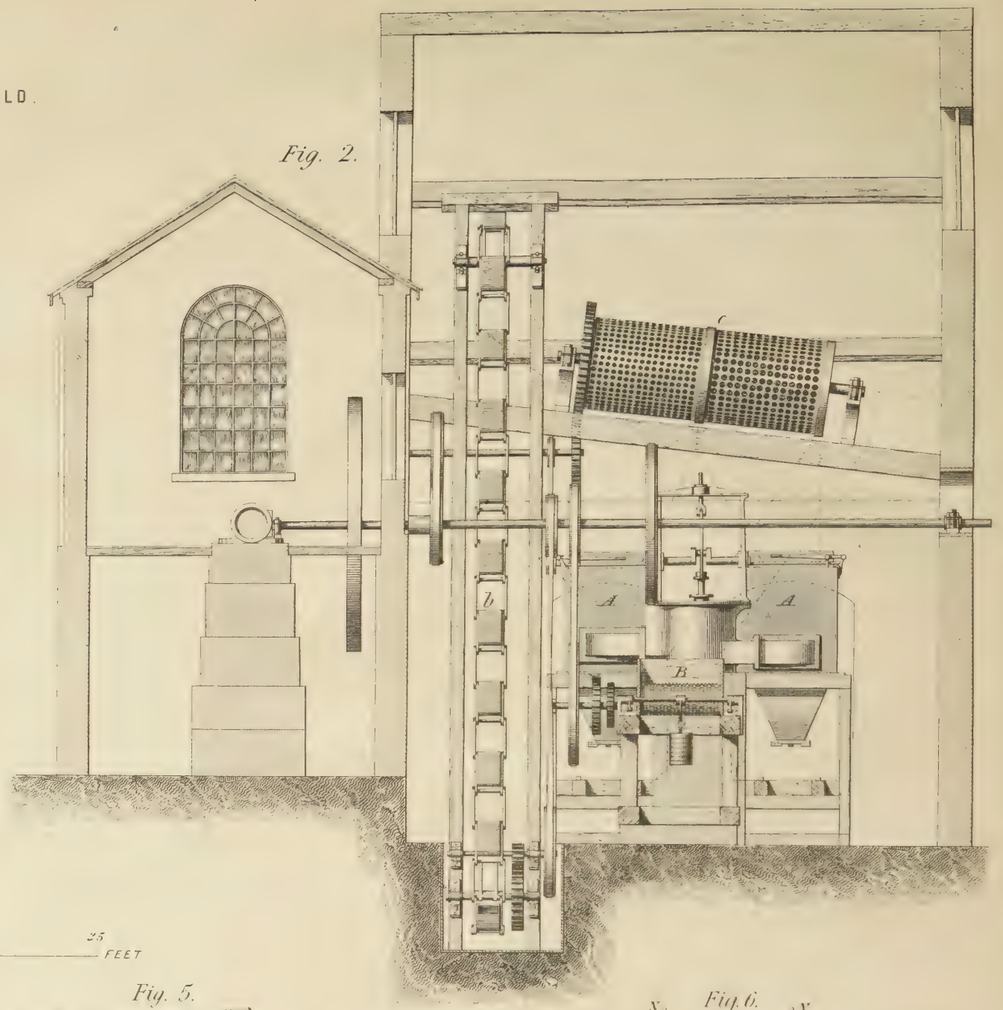


Fig. 3.

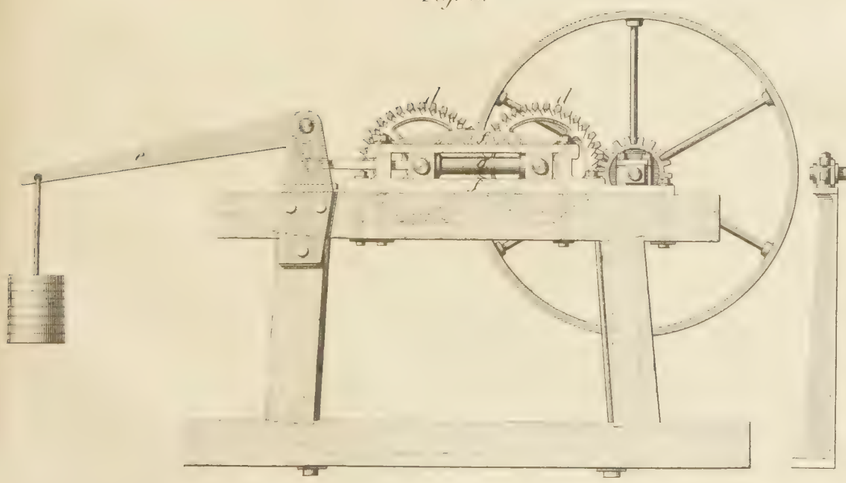
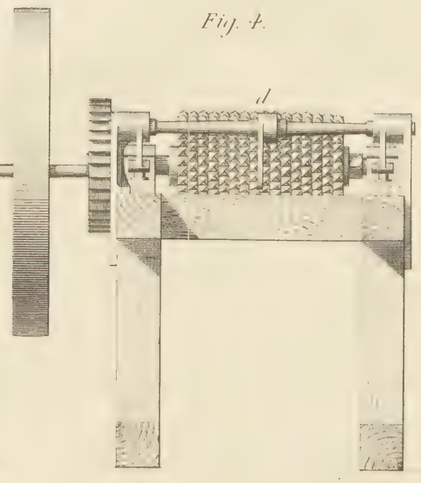


Fig. 4.



Scale for Figs. 3 & 4 ½ in. – 1 Ft.

Fig. 5.

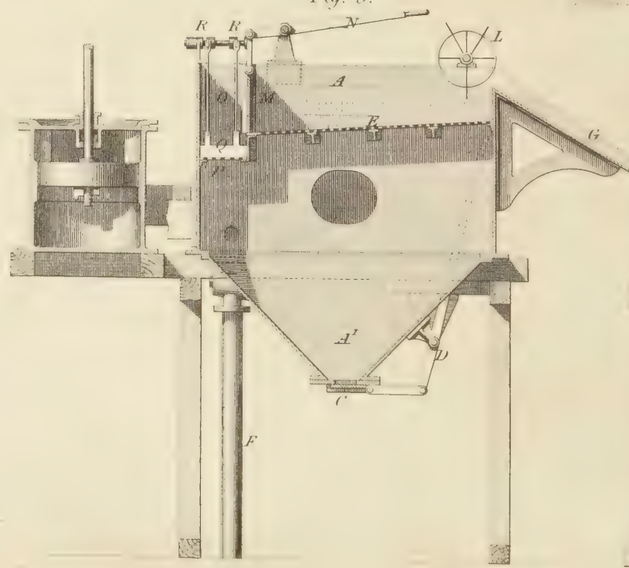
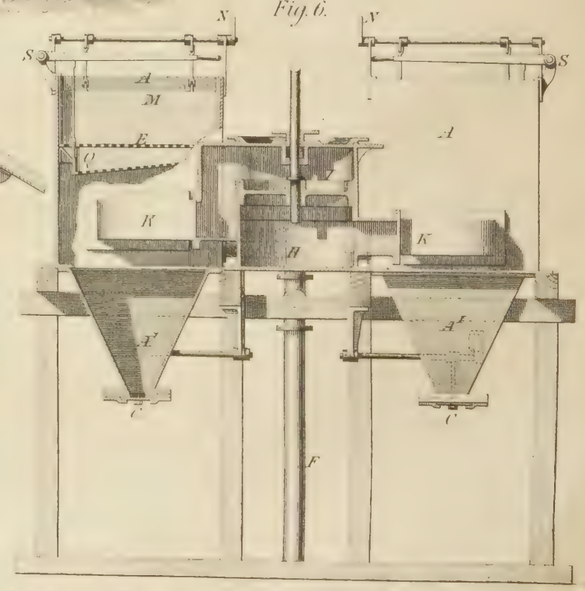


Fig. 6.



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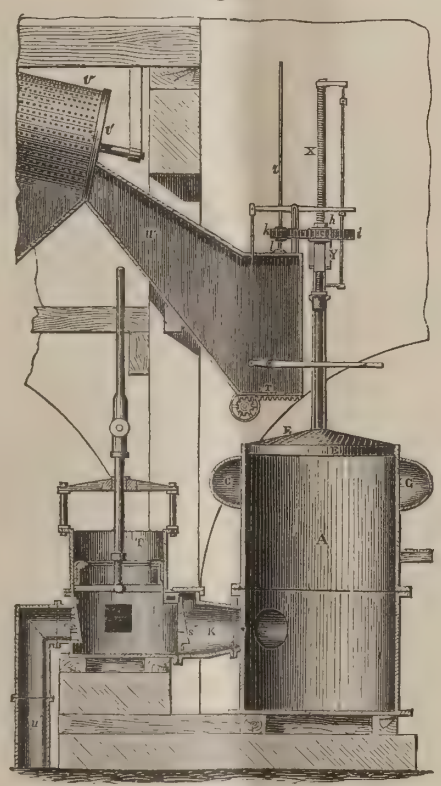
the reciprocating motion of the piston in the cylinder will agitate the water in the vessels and force it through the perforations in the false bottoms, thereby causing pulsations to be imparted to the substance to be acted upon; the effect being that the bodies arrange themselves according to their specific gravities, the heaviest remaining on the perforated false bottom, and the lightest, such as coal, being carried with the stream of water, assisted by rotatory rakes or scrapers, L, over the front or lowest edge of the vessels into the discharge spouts, G, whence they fall into waggons or other receptacles. The false bottoms, E, should be caused to incline downwards slightly towards the back of the vessels, as shown; and at the lower end thereof there is fitted a sliding door or sluice, M, extending from side to side of each vessel, such sluice being opened or closed by a lever, N, or other convenient contrivance. Immediately behind this sluice, at the back part of the vessels, a chamber, O, is formed, the perforated bottom, P, of which dips towards one side of the vessel, and is made rather lower than the false bottom, E. At the lower end of the bottom, P, there is fitted another sluice, Q, at right angles to the first, and worked by levers, R, fast on a rocking shaft, S. The heavy substances which settle or become deposited upon the false bottom, E, are allowed either constantly or at suitable intervals to pass under the sluice, M, into the chamber, O, the sluice being opened for that purpose by depressing the lever, N. From this chamber they are discharged, by opening the sluice, Q, into the lower portion, A′, of the vessels, A, beneath the false bottoms, where they collect, and are thence discharged at intervals into waggons by opening the sliding dis-

Fig. 2.



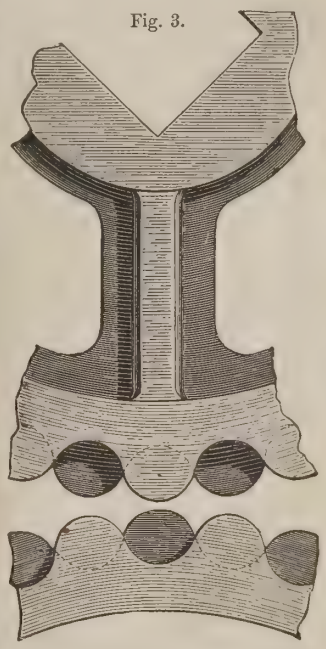
charge doors, C. Before the refuse matter (when coal is being washed) is let off into the lower part of the vessel, the attendant can readily ascertain if any coal has been carried under the sluice, M, along with the refuse matter, as it will by the pulsations be brought to the surface, whence it may be removed and returned to the body of the coal undergoing the washing process. When using two washing vessels, it is preferred to make the perforations in one-half of the length of the cylindrical screen, C, finer or smaller than the perforations in the other half, and to have a separate spout leading from underneath each half of the screen to its respective washing vessel, whereby the two vessels will be supplied with coal of different sizes.

Mr. Birkbeck's system of washing is also applicable to the treatment of ores, and three machines specially adapted for the purpose have been for some time in successful operation at the Sheepbridge Ironworks for washing ironstone.

Fig. 2 of our woodcuts is a sectional elevation of one of the washing vessels and parts connected therewith, as now employed in the washing of ironstone.

The calcined glomerated ironstone is taken from the heap and tipped on to a shoot, which conveys it to a pair of crushers, the rolls of which are specially adapted for the purpose. These rolls are disposed in two pairs, one above the other, and are in general construction similar to those employed in the crushing of coal; but in lieu of the teeth or projections being of a pyramidal form, and made to gear with each other, they are rounded in the form of knuckles, and work immediately opposite each other, or point to point, as shown in the detail woodcut, fig. 3. The knuckles in the lower pair of rolls are made smaller than those in the top pair, in order to still further reduce the material which falls through the upper rolls. The hard lumps resembling slag which are sometimes formed during the burning or calcining of the stone, should be carefully picked out before supplying the ore to the crushers. After leaving the crushers the stone falls into an inclined revolving screen, a part of which is shown at V, in the woodcut, fig. 2. This screen is divided into two parts, the upper part being of fine mesh, in order to allow the very small fragments to pass through into a spout, which discharges it into waggons. This fine refuse matter is found to produce an excellent mortar when mixed with lime. The other half of the screen allows the fragments of rather larger size to fall on to a spout, which conveys them to a single washing vessel; the largest fragments pass out at the end of the screen into the hopper, *w*, provided with a sliding door, *x*, and thence to the separate pair of washing vessels, A, one of which only is shown in the woodcut. Each washing vessel is connected with a pump of its own, the piston, *r*, of which is worked by an overhead crank, the valves, *s s′*, serving for the raising of the water from a well, through the suction pipe, *u*, and for the discharge of such water through the pipe, K, at the next descent of the piston, *r*, into the cylindrical washing vessel, A. Each washing vessel is provided with a perforated piston, E, having a convex top or surface. This piston is connected to a rod, X, which has a screw-thread formed upon it, and works through a stationary nut, *h*, in an arched standard or bracket, Y, carried by the washing vessel. The piston is capable of being moved up and down within the vessel by the nut, *h*, working on the screwed portion of the piston rod, and actuated by the spur wheel, *i*, pinion, *k*, spindle, *z*, and bevel gearing and clutch, driven from the overhead crank shaft that drives the pumps. On a rod connected to the piston rod, X, by short arms, and situate by the side of, and parallel to the piston rod, are fitted two adjustable tappets, which allow the piston, E, to travel various distances as required, by their coming in contact with a lever connected to the hand gear, for reversing the clutch box and throwing the same out of gear when the piston arrives at the end of its course either upwards or downwards. The hopper, *w*, having been filled with crushed ironstone and gritstone, the attendant throws the clutch box into gear, when the piston, which is now at the top of the washing vessel, as shown in the woodcut, begins to descend slowly. The sliding door, *x*, is then opened by means of a hand wheel acting upon a rack and pinion, and the material falls on to the piston in the cylinder. After traversing the distance regulated by the position of the tappet, say 3 feet, the tappet lever is forced down until the clutch box is thrown out of gear, and the vessel is then allowed to be filled with the material to be operated upon. The hopper slide is now closed, and water is forced upwards through the perforations in the piston at each stroke of the pump, so as to cause the material to be agitated in pulsations; the effect of which is that the materials arrange themselves on the cylinder according to their specific gravities, as before explained. In a short time the attendant throws the clutch in gear in order to raise

Fig. 3.



the piston, and the lighter material, with the raising of the piston and the force of the water, is carried over the edge of the vessel, and falls on to the inclined spout, G, surrounding the vessel, whence it is discharged in waggons or other suitable receptacles. After the lighter material, which in this case constitutes the *refuse* matter, has been washed over the vessel, the waggon is shunted, and replaced by an empty one. During the change of waggons the attendant throws the clutch out of gear, and when the empty waggon is in position the clutch is again thrown into gear, when the piston continues to rise slowly, and the heavy material or ironstone is thrown over the edge of the washing vessel into the spout, and discharged into the waggon. By the time the piston reaches the top of the vessel, the tappet strikes the lever and throws the clutch out of gear, by which time the entire charge will have been removed from the washing vessel, which is ready for a fresh supply as before.

In the arrangement at present in operation three separate washing vessels are employed; those for the larger fragments being about 4 feet 4 inches diameter, and containing a depth of material of about 3 feet, thus giving 44 cubic feet of material in the washing vessel at each full charge. The diameter of the washing vessel into which the small fragments are discharged is 4 feet 8 inches. The pumps in each case are of the same size, namely, 2 feet 6 inches diameter, with a stroke of 7 inches, and working at a speed of 46 strokes per minute. The time occupied in washing off a charge is about thirty minutes. The material operated upon is composed of about one-half of ironstone and the remaining half of gritstone, and when freed from the refuse matter, yields in the blast furnace about 48 per cent. of metal. Economy of water has not been overlooked in these machines, as provision is made for using it over and over again. To this end broad culverts of brickwork lead from the washing vessels to wells underneath the floor, protected on the side next the culverts with gratings, which exclude, to some extent, the entrance of grit to the wells and pumps. As a further precaution against the clogging of the pumps, a small stream of water is kept constantly running on to the top of each piston or bucket, which is found to answer the purpose effectually.

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RECENT PATENTS.

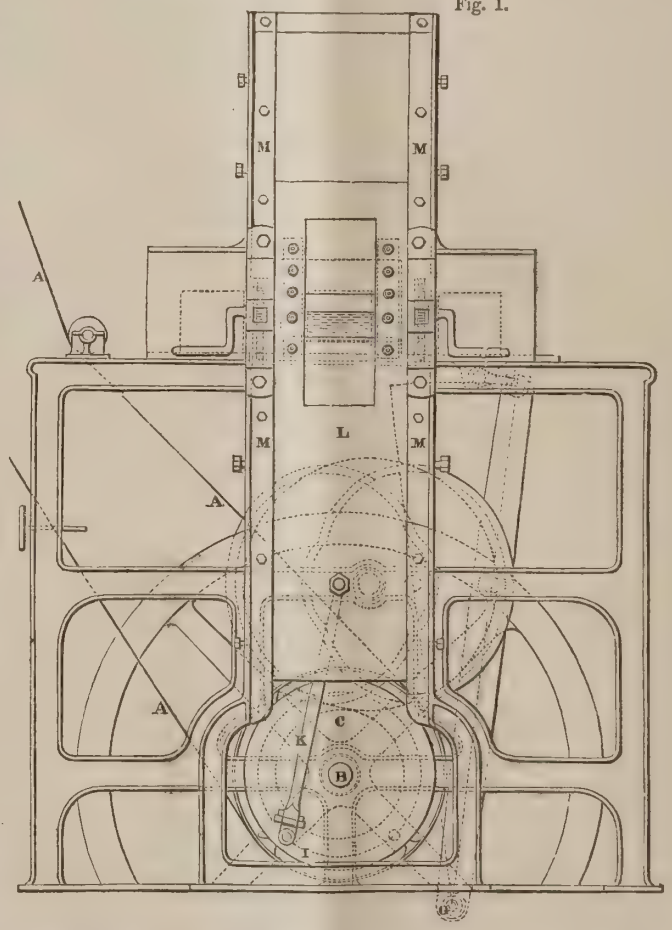
CUTTING AND DIVIDING TIMBER.

JOHN JEX LONG, *Glasgow.—Patent dated October*, 1865.

THIS invention relates to a novel arrangement and combination of certain parts of mechanism, and has for its essential object the cutting or dividing of timber with great rapidity and perfection into small pieces or splints, such as those used for the manufacture of lucifer matches, pencils, and other generally similar purposes. The apparatus consists of a strong iron frame, in the lower portion of which the main shaft revolves by means of a belt actuating a pulley fixed thereon. At one end of the shaft a fly-wheel is fixed, whilst at the other end a crank or cam is attached, and a connecting rod extends from this to the movable block, or frame, carrying the knife or knives by which the vertical cut in the wood to be divided is made. As the cam or crank revolves, its eccentric or circular motion is converted by means of the connecting rod into a vertical reciprocating motion of the knife or knives. On the top of the frame-work, V or other shaped slides are fixed, and on these travels the saddle or table carrying the pieces or blocks of timber to be divided. The table is furnished with two gutters above, into which the blocks of timber previously cut to the required shape and size are placed. The table is caused to travel horizontally on the slides, and thus the faces of the two blocks being cut are alternately brought in front of the knife or knives. The horizontal movement is imparted to the table by means of a cam fixed into the main shaft. The cam is grooved, and into this groove enters an antifrictional roller on a stud projecting from the side of a strong lever. Therefore, as the cam revolves the lever is caused to vibrate, and its upper end being coupled to the table or saddle carrying the two blocks of wood, imparts the necessary reciprocating horizontal motion to it. Attached to that portion of the framework in which the vertically-acting knife or knives are located, is a projecting set or sets of knives which cut into the blocks of wood as they alternately travel before them; by these means the wood is first divided into a number of horizontal strips, needing only the downward motion of the knife to separate them in the form of rectangular bars from the block or blocks of timber. The splints are thus at once produced in a state fit to be used for any of the purposes before described. As soon as one downward cut has been made the table travels back to its former position, and the other block is similarly treated. It should be mentioned that the table is fitted with two sets of forwarding gear, by means of which, as soon as one set of splints have been cut off, the block of wood is forced on a distance sufficient to allow an equivalent portion to be divided or cut off for the next set of splints. There are many kinds of forwarding gear which will fulfil the conditions required.

Fig. 1 is an end elevation of the improved machine for cutting and

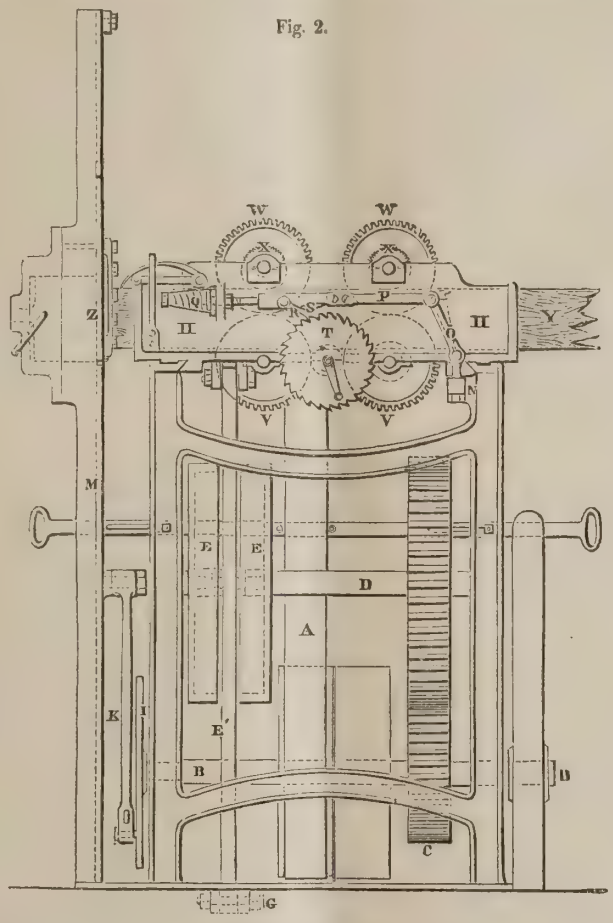
Fig. 1.



dividing a block of wood into splinters for making matches. Fig. 2 is a side elevation corresponding to fig. 1. The machine is set in motion by the belt, A, actuating the fast pulley of the set of fast end-lever pulleys on the shaft, B. The pinion, C, on the main shaft, B, actuates a corresponding spur wheel on the cam shaft, D. Each half of the cam, E, on the shaft, D, is provided with a groove in which the antifriction rollers, carried on studs in the lever, E^1, revolve as the machine is in motion. The lever, E^1, vibrates on a bolt, G, as its centre, fixed to the bed or framing of the machine. The upper end of the lever, E^1, is connected by a similar joint to a short connecting rod, by which it is coupled to the saddle, H, so that as the cam, E, revolves, it communicates a horizontally reciprocating motion to the saddle, H. The main shaft, B, is furnished at its front end with a disc crank, I, from which the connecting rod, K, passes, and is coupled to the knife frame or plate,

D, which, as the crank revolves, is caused to reciprocate in the vertical slide, M. One side of the frame on which the saddle, H, reciprocates is furnished with two inclined or wedge-shaped projections, N, against which the levers, O, strike and pass over during each stroke of the saddle. Both sides of the saddle are furnished with the levers and other arrangements shown at fig. 2, for propelling the timber, Y, to be divided by the knives or cutters against the face plate, Z, at the commencement of each stroke; and it is to be understood that the horizontal dividing or cutting of the blocks is effected only as the block of wood to be divided approaches to its position under the vertically-cutting knife. After the splints are removed, the block returns clear of the dividing knives. As the short end of the lever, O, passes over the projection, N, it draws the upper and longer end forward, together with the bar, P, coupled to it; the latter end of the bar, P, is furnished with adjusting nuts and screws for regulating the tension of the spring, Q: the position of the adjusting nut also regulates the extent of travel in a backward direction both of the bar, P, and the lever, O. The bar, P, is provided with a detent or pawl, R, which is forced in a downward direction by the spring, S, into

Fig. 2.



the teeth of the ratchet wheel, T; thus each time the lever, O, passes over the projection, N, and the rod, P, is impelled forward, the ratchet wheel, T, is caused to revolve in a proportion corresponding to the extent of motion of the lever, O. A detent spring, S, is attached to the saddle for the purpose of firmly holding the ratchet wheel, T. The use of this last-mentioned arrangement is to propel the blocks of wood to be divided against the cutters, and this propelling is effected in the following manner: The shaft carrying the ratchet wheel, T, is furnished at its inner end with a pinion, U, the pitch line of which is shown dotted in fig. 2; this pinion gears into the tooth wheels, V, one on each side of it, which in turn also gear into similar tooth wheels, W. The shafts of the wheels, V and W, carry on them the toothed propelling rollers, X, and these acting upon the pieces of wood, Y, cause them to be brought forward at the beginning of each stroke against the face plate, Z, to an extent necessary to allow the next cut of the knives to be made. In order to cut both blocks of wood that are being divided, the vertical cutting knife, actuated by the disc crank off the main shaft, moves at double the rate of travel of the saddle, so that the knife is ready to make the cutting stroke immediately that either one or the other of the two blocks of wood, Y, arrive in position in front of the cutting plane. The machine is furnished with two sets of knives, *a a*, for cutting or dividing the blocks of wood horizontally. These knives, *a a*, are stationary, and enter the blocks of wood as these pass by them, and they project to an extent corresponding to the depth of cut required. Thus, it will be seen that before the downward or cutting stroke of the knife is made, the blocks of wood are already divided horizontally; therefore, when the cut of the vertically-acting knife is made, the wood comes off in rectangular bars at the front of the machine, suitable for the purposes to which they are to be applied. The front ends of the troughs carrying the blocks of wood may be furnished with pinching screws for the purpose of more securely holding the wood as its length becomes reduced. Each set of the little knives, *a a*, are fitted into a metallic block, which slides in a recess in the main framing, and the block is furnished with a hole through which an ordinary eccentric passes; the short shaft carrying the eccentric being provided with handles, by which the knife-holding box, *d*, is drawn back when required behind the level of the face plate. Such is necessary when a hard knot occurs in any of the blocks of wood being acted upon, in which case the vertically-acting knife is used to remove the knotty portion in flakes, and as soon as this is effected the horizontally dividing knives are again thrown into action. The advantage resulting from the machine is that, owing to the blocks of wood being first divided horizontally and then detached by the vertically-cutting knife, the splints are obtained in a rigid parallel condition.

IMPROVEMENTS IN TREATING AND PURIFYING WATER.

ROBERT IRVINE, *of Magdalen Bridge, near Musselburgh, Mid Lothian, N.B.*—*Patent dated August* 28, 1866.

THIS invention has for its object the purification of water containing such impurities as exist in sewages, the dirty or coloured waters discharged from calico printing, dyeing, paper, and other works, as also the decolorization of peaty and mossy waters.

For these purposes it is proposed to employ mineral charcoal obtained by the process after described, and containing silicate of alumina, free alumina, or disilicate of that earth, together with certain proportions of lime, magnesia, oxides of iron naturally present in the raw material, and with carbon in a free and finely divided state, in combination with the matters after referred to. For this purpose shale, such as is used for the manufacture of paraffin oil, is distilled or heated in retorts, or close vessels to which heat is applied; and after the oil resulting from the destructive distillation of the bituminous portion of the shale has been expelled and collected, the residuum remaining in the retort is withdrawn, and quenched in water. By this means a mineral charcoal is obtained, possessing the power of disinfecting and decolorizing the beforementioned fluid matters to a high degree, on account of the presence of a larger amount of carbon in a fine state of division, as also the fact that the alumina and the silicates of that earth are in a more amorphous state than when the residuum from the retorts or coke is allowed to cool by exposure to the air, when combustion ensues, and vitrific action more or less takes place.

In carrying out this invention in practice, it is preferred to use the said materials ground to powder, and in some cases suspended by stirring or other means in the water to be purified, the suspended materials being subsequently allowed to settle with the colouring matter in ponds or reservoirs. Sometimes, however, it is preferred to construct a filter of the said materials, so formed that it is sufficiently porous for the free passage of the liquid through the bed or beds of the filtering medium, which is, or may be used; and the effect is the complete withdrawal or renewal of the organic colouring matters present, which is the result of a peculiar and strong affinity which alumina may by its combinations possess for such colouring matters, and at the same time the partial or total withdrawal of azotized matters, more especially in the latter case, applicable to sewage containing urinary and fæcal matters in solution and held in suspension.

In certain cases the above described aluminous charcoal is used after a proportion of sulphuric acid has been added thereto, or any other acid which has the power of setting free the alumina from its combination with the silicic acid present therein, and heating the resulting product to redness, by which means (as is well known to chemists) alumina in a free state is obtained, or rather a compound of alumina

and silicic acid mechanically mixed in place of being chemically combined, and which from the larger amount of available alumina (or subsulphate of alumina) therein, is found to exert greater purifying power, and a more lasting result, than from the unprepared minerals or residua. It is also preferred that in all cases free carbon be present, as from the porous nature of the materials described, the carbon has the same power in such case which it exerts in animal charcoal, and assists in the decolorization of any impure liquid passed through it.

In the event of the impure aqueous discharges being associated with solutions of bleaching powder, to the mineral composing the filter any of the insoluble sulphides of the alkaline earths or cheap metals are added; but it is preferred to make use of those sulphides, the salts resulting from which on their combination with the bleaching liquor or chloride of lime have no prejudicial effect on the water; it is preferred in most cases to use the sulphide or sulphides of calcium, of which there are abundant supplies at a nominal cost, in the shape of alkali waste and gas lime refuse. The sulphide of calcium is oxidized previous to use by exposure to air, by which means sulphites and hyposulphates of lime are obtained.

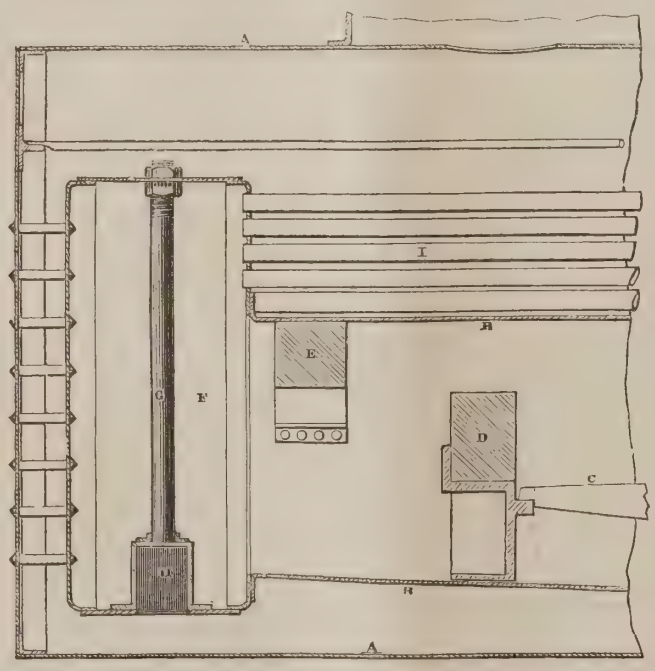
Any of the foregoing described processes are applicable to deodorizing, and disinfecting, and effecting the abstraction of azotized matter, and to abstracting soluble organic colouring matter from polluted waters, also to purifying mossy water, and rendering them innocuous, and in the case of moss water fit for household purposes.

In the event of the impure waters containing fibrous matters, or solid substances in suspension, these are removed by passing the impure fluid or fluids through a filter composed of gravel to remove the same, and disinfect or decolorize the liquid after its passage through the said filter, by means of the above mentioned process; and especially in the water from paper factories, where it is of importance to collect the fibre floating or suspended therein, a filter composed of layers of canvas or any fibrous material is used, from which the fibre can be collected and made use of for manufacturing coarse papers.

STEAM GENERATORS.

ROBERT DAGLISH, *St. Helens, Lancaster.—Patent dated August* 30, 1866.

THIS invention relates more particularly to multitubular self-contained or other steam generators provided with a combustion chamber, and



consists in the application and use to and in the combustion chamber of a number of water tubes placed vertically, or nearly vertically, therein, such tubes opening at the lower end into the water space beneath the combustion chamber, whilst their upper ends communicate with the water space at the top of the said chamber. It is preferred to situate the combustion chamber at the rear end of a cylindrical flue containing the furnace grate, and that the products of combustion pass along a series of return tubes disposed above the main cylindrical flue, and communicating with a smoke box at the front of the boiler above the fire-door. The advantages obtained by the use of the water tubes in the combustion chamber are, increased heating surface and better circulation of the water, whilst, as these tubes act as stays, the combustion chamber is considerably strengthened, provision is made for removing the vertical tubes, and thus enabling any repairs to be done to the horizontal tubes.

The accompanying engraving represents a transverse vertical section of a steam boiler or generator constructed according to this invention. A is the outer shell of the boiler, and B is a circular flue containing the furnace, C. D and E represent respectively the ordinary fire bridge at the back of the furnace, and an inverted bridge situate at the entrance to the combustion chamber, F. This combustion chamber is provided with a number or series of vertical water tubes, G G, disposed in one or more rows which open at the bottom of the chamber into a hollow water bridge or chamber, H, communicating directly with the water space of the boiler beneath the bottom of the combustion chamber, whilst their upper ends open into the water space above the combustion chamber, so that a free upward circulation of water may take place through these tubes. When practicable, it is preferred to employ a number of return tubular flues, I, disposed above the main furnace flue, as shown in the engraving. These return tubes, I, open at their back ends into the combustion chamber, and at their front ends into a smoke box situate in the front of the boiler. In order to facilitate the removal of the water tubes for the repair, removal, or cleaning of the tubular flues, I, it is proposed to secure the water tubes, G G, by nuts at their upper ends, such nuts screwing on to threads cut on the exterior of the water tubes at their upper ends, and being tightened respectively against the upper and under surfaces of the crown of the combustion chamber, the lower ends of the tubes, G, being fitted into sockets as shown.

TANNING HIDES AND SKINS.

GEORGE MOUNTFORD, *Grasscroft, near Greenfield, York*, and G. L. LOVERSIDGE, *Manchester.—Patent dated* 23*rd July*, 1866.

THIS invention relates to an improved method of tanning by the employment of valonia, or of valonia and oak bark, in conjunction with what is known in commerce as American pearlashes (and which, as is well understood, consists essentially of carbonate of potash), whereby a considerable diminution of the time required for the process of tanning is effected, and a leather or tanned hide or skin of superior quality is obtained. In cases where it is advisable to give a yellowish colour to the leather, turmeric may be used with the valonia or valonia and oak bark.

In carrying out this invention, it is preferred that the hides or skins should have undergone the ordinary preliminary treatment of liming, fleshing, and unhairing; and when sufficiently well prepared they are submitted, firstly, to the action of a bath composed of a solution or extract of valonia marking about one degree on the Twaddell's hydrometer, and of American pearlashes, which have been added in the proportion of about 4 lbs. to every 160 gallons of such bath. The hides or skins are handled about three times a day for about three days, when they are removed to a second bath, which is composed of a solution or extract of valonia marking about three degrees on the hydrometer, and of American pearlashes added in the proportion of about 5 lbs. to every 150 gallons of such bath. The hides or skins are allowed to remain in this bath for about four days, they being handled about twice per diem. After the expiration of the fourth day, the hides or skins are placed in a bath consisting of a solution or extract of valonia marking seven degrees on the hydrometer, and of American pearlashes added in the proportion of 5½ lbs. to every 150 gallons of the bath. In this bath the hides or skins are allowed to remain for about seven days, during which period they should be handled about four times. In some cases, where very thick hides are operated upon, they may at this stage of the process be with advantage transferred to another bath, consisting of a solution or extract of valonia marking nine degrees on the hydrometer, and of American pearlashes in the proportion of 2½ lbs. to every 150 gallons of the solution composing the

bath: in this bath the thick hides may be allowed to remain for about nine days, more or less time being required according to the nature and thickness of the hides operated upon, as may be ascertained by cutting and examining the hides, as is well known by persons familiar with the tanning process. In the case of hides of ordinary thickness, they will not need to be subjected to the action of the bath, where, as stated, thick hides may be treated and allowed to remain nine days (being handled three times during the nine days), more or less; but they should be transferred from the bath, where, as above stated, they should be treated and allowed to remain seven days, to the bath which may be termed the final bath, which is composed of a solution or extract of valonia marking nine degrees on the hydrometer, and to which are added 2½ lbs. of American pearlashes to every 150 gallons of such bath. Between each hide or skin, as they are placed in the bath, about 6 lbs. of oak bark or valonia are scattered or strewn; and they are allowed to remain therein for about fourteen days, when they are removed and finished in the ordinary manner. The very thick hides should also be treated in the bath termed the final bath for a period of fourteen days, more or less. Instead of valonia, ordinary oak bark, or other equivalent tanning materials, may be employed; and instead of American pearlashes, which are considered to be most advantageous, the constituents forming American pearlashes may be employed.

Although certain proportions of valonia and American pearlash and of oak bark are here given, and about the duration of time necessary for effecting the tanning of the hides or skins stated, it will be understood that these will vary according to the materials to be operated upon and the result desired to be obtained. In cases where it is not necessary to give to the leather the colour imparted by turmeric, that material may be dispensed with. It should always be borne in mind that the baths employed respectively should be maintained at about the strength indicated; and as the materials of which they are composed are taken up or removed during the processes of treating in them the hides or skins, as described, fresh materials should be added from time to time to replace those that may have been removed.

MANUFACTURE OF MINERAL OIL AND WHITE LEAD.

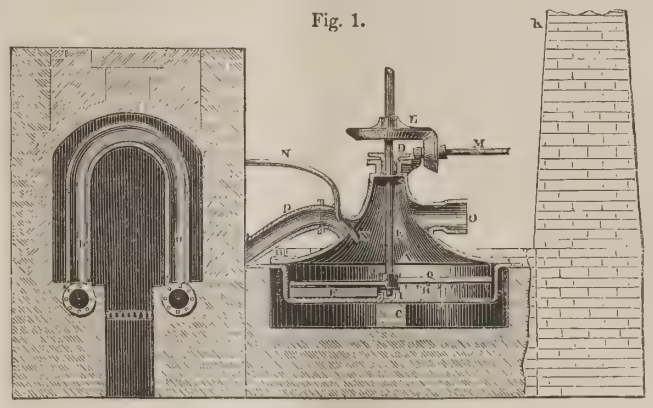
HUGH ROBERTSON, *Omoa Foundry, Motherwell.—Patent dated February* 28, 1866.

THESE processes and apparatus relate to the manufacture or obtainment of oil and other bituminous substances from shales, and also to the conversion of lead into what is commonly known as white lead. The apparatus employed for effecting the above purposes consists mainly of a hollow cylindrical or other shaped vessel, with closed or partially closed ends, and which is carried on a revolving central axle or shaft. The material (to be acted upon by the air and steam) is first pulverized, and a quantity is placed in the vessel, after which the vessel is caused to rotate slowly as the steam and air act on the material therein. The heat (in the case of shales, for example) causes a complete and very rapid extraction of the oils and other products, which may afterwards be separated from the carbonaceous residue by any well-known means; and sodium, in one of its commercial forms, may be added in the course of the process of extraction in order to facilitate the separation and improve the result. In the case of manufacturing white lead the routine of the process is somewhat similar to that above described, lead being substituted for shale, and a portion of carbon added in order to improve the purity and colour of the product.

Fig. 1 is a part section and elevation of one form of apparatus employed for the manufacture or extraction of the fluid hydrocarbon from shale, coal, and other bituminous substances. In the figure the vessel, A, is that in which the pulverized material from which the hydrocarbon is to be extracted is placed; it is set in brickwork, and maintained in position by its flanch, B, resting on the upper side of the bricks, whilst its lower central part is supported by resting on the partition, C. The upper part of the vessel, A, is made of a convex conical form, and at the top of it a stuffing box, D, is formed, for securing an air or gas tight joint around the central shaft, E, for actuating the agitator, F. In the furnace, G, the heaters, H, are placed, which are of the same kind as those employed for heating the blast for blast furnaces, and the heated air passes therefrom through the pipe or passage, P, to the extracting vessel, A. The waste heat which passes off from the furnace, G, passes through flues, I, which are situated under and around the extracting vessel, A, and the products thereafter remaining escape into the chimney, K. Thus the whole, or as much as possible, of the heat of the fire on the grate is utilized, thereby avoiding the necessity of another or second fire for heating the vessel. The agitator, F, is put in motion by means of the bevel wheel, L, in the shaft, E, being rotated by the bevel pinion, M. Steam is introduced by means of the pipe, N, the use of which is after more fully referred to, and the volatile products resulting from the operation pass off to a condenser or condensers through the pipe attached to the socket, O.

The mode of operating with the same is as follows:—The material to be distilled is first ground in a riddle-bottomed pan-mill, after which

Fig. 1.



it is sifted. The finer portions are then mixed with rosin, sawdust, or dry mould (the mixture being made dry). To the foregoing there is now to be added a small quantity of a solution of carbonate of sodium, together with two to three gallons of crude shale or coal oil, the whole of the ingredients being now thoroughly commingled by any convenient means, after which the portion of the shale or coal which did not pass through the sieve is to be added. The vessel, A, is now charged with this mixture, care being taken that the layer is not more than 6 inches deep or thereabouts. The heaters, H, are now raised to a temperature of from 700° to 800° Fahr., and this temperature acting upon the air passing in through the heaters, expands it sufficiently to produce a sufficiently rapid and heated current through the vessel, A, without requiring any kind of blowing apparatus; the passing in of the heated air is also facilitated by the egress of steam from the pipe, N. The vessel being thus charged, the agitator, F, is now set in motion in the manner and by the means before referred to, at a rate of from two to three revolutions per minute. The action of the agitator as it revolves, is that it heaps up and constantly turns over the material under treatment, thus continually exposing fresh portions of the charge to the action of the hot air and steam; and the charge being so finely divided beforehand, the products pass over from it with much more freedom than when distillation is effected with the material in the solid state: at the same time, the sawdust or mould being mixed with it prevents congelation of the compound taking place. On the opposite side of the shaft, E, the bar, Q, is fixed, and is fitted with teeth, R, so that whilst rotating along with the agitator, F, it causes a further exposure of the charge, and at the same time keeps the layer of a uniform thickness in the vessel's bottom as the process is continued. The before-mentioned temperature is to be maintained constant during the whole time the distillation is being conducted; and the carbonaceous residue may be ground, and used by ironfounders for blacking their moulds.

Fig. 2.

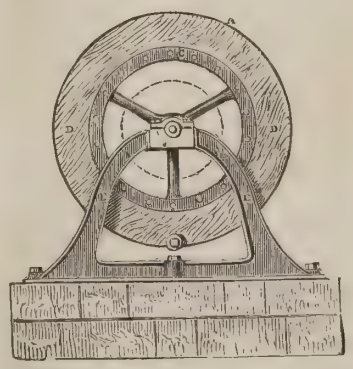


Fig. 2 represents an end elevation, and fig. 3 a side elevation of the apparatus which it is preferred to employ for the manufacture of what is commercially known as white lead. The drum, A, is carried upon a central shaft, B, the shaft passing through the bosses held in the centre

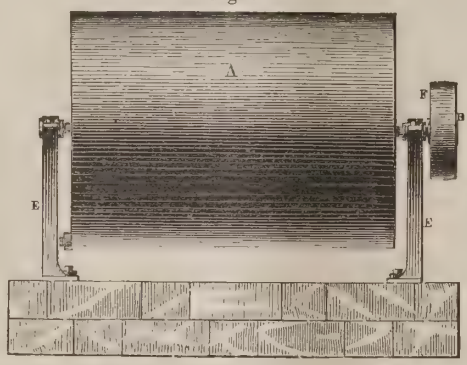
of the arms, which are connected to the rings, C, and thence bolted to the annular ends of the vessel in the manner shown. The annular ends, D, are by preference made of wood. The journals of the shaft, B, are fitted into bearings in the standards, E, and rotatory motion is imparted thereto by a belt passing over the pulley, E.

The mode of conducting the process of making white lead, by the apparatus now described, is as follows—it being, however, first premised that the process is conducted solely in a *humid* way.

First, the lead to be converted is melted, and a quantity of carbonate of sodium is dissolved in an adjacent vessel: the melted lead is now slowly dropped into the solution of carbonate of sodium, and the vessel from which the lead is dropped should be so situated that the lead may fall about three feet before meeting the solution; by this means the lead is divided into small flakes or granules, and is now ready for the further process.

Second, the contents of the vessel containing the solution of carbonate of sodium and the granulated lead are now poured into the annular space of the revolving vessel, figs. 2 and 3, in such quantities as the vessel will conveniently hold. The vessel is now caused to revolve, and during the period of its rotation the interaction of the

Fig. 3.



contents takes place, the solution in the vessel having in a short time the whiteness of milk. At this point the rotation is stopped, and the milk-white solution is drawn off through the stop plug: this is repeated as often as may be required. During its agitation, the lead being exposed to the action of the atmosphere, and having a great affinity for carbonic acid, takes up so great a quantity as more than compensates for any loss in weight caused by the oxidation of the lead during the smelting.

Thirdly, after the milk-white solution has been drawn off, it is filtered, and to the filtrate a little more carbonate of sodium is added, when it is returned to the vessel and submitted to the same agitation as before.

In lieu of using the apparatus now last described for manufacturing the carbonate of lead, a part of that beforementioned for the extraction of the products from coal, shales, and other bituminous substances may be used. That is to say, a vessel fitted with an agitator similar to the vessel, A, fig. 1, may be employed, and situated at an angle of 20 degrees or thereabouts, the mixture of lead and solution of carbonate of sodium being placed therein, in lieu of the vessel shown at figs. 1 and 2, the action of the agitator, F, causing it to be elevated a short distance, when it falls over to the bottom of the vessel. And in place of using the apparatus shown at fig. 1, for conducting the extraction of the products from bituminous substances, a vessel with completely closed ends, and having a hollow axle or shaft passing through it, may be employed, the tubular passage being divided in the centre, so that the hot air and steam may be conducted into the vessel through perforations in the hollow axle, and the products arising from the distillation passing off through similar perforations in the other half of the shaft.

It is to be understood that zinc may be manufactured into a white carbonate in the manner described with reference to lead; zinc being substituted for lead in conducting the process. After the carbonates are manufactured, all that remains to render them fit for use is to wash and dress them in the usual manner for the market. A great advantage resulting from this mode of manufacturing the carbonates is that the process is much less expensive than the present mode, a great saving of time being effected; and the operations are in no way injurious to the health of the operator, as in the methods at present practised.

LAW REPORTS.

BETTS *v.* NEILSON.—METALLIC CAPSULES.—Before Vice-Chancellor Sir W. P. Wood, March, 1867. The bill in this case was filed to restrain an infringement of the plaintiff's patent obtained in 1849, and prolonged for a further period of five years by the Privy Council in 1862, "for a new manufacture of capsules, and of a material to be employed therein," and the case made was that Messrs. J. & R. Tennent, of Glasgow, who are manufacturers and exporters of bottled beer in large quantities, have been in the habit of covering their bottles with capsules alleged to be an infringement of the plaintiff's patent, and of sending such bottles to their agents in Liverpool and London for transhipment and exportation to India, China, and elsewhere.

The defendants contested the validity of the plaintiff's patent, on the ground (which has been so often urged against Mr. Betts during the last ten years) of anticipation by a patent taken out by one Dobbs early in the present century; and upon this question of anticipation some new evidence of user, supplementing that given on former occasions, was now adduced. It was also contended that even assuming the validity of the patent, and that these capsules were made in infringement of it, the mere transhipment of the cargo at Liverpool or London from the Glasgow vessel to that sailing for the foreign port to which the cargo was consigned, was not such a user of the invention in this country as to constitute an infringement of which the Court could take cognizance. The arguments occupied nine days.

Mr. Willcock, Q.C., Mr. Grove, Q.C., and Mr. Everitt were for the plaintiff; the Attorney-General, Mr. Giffard, Q.C., Mr. Aston, and Mr. Wickens were for the defendant.

The Vice-Chancellor, in a judgment which occupied three hours in delivering, decided in favour of the plaintiff upon all the questions raised, holding that the defendants had failed to establish such a user of the invention patented by Dobbs (and which seemed, as he had observed in the former cases, to have remained a mere experiment brought to no useful or practical result) as would invalidate the plaintiff's patent by anticipation. Upon the legal question of infringement, the defendants remained owners of the cargo while it was lying in the docks at Liverpool or London, while the capsules, the object of which was not for mere ornament, but to prevent injury to effervescing liquors from the access of air, moisture, or insects, were performing their function by securing the bottles, and therefore, having regard to the nature of the invention, and also to the profit made by the defendants by affixing the capsules to their beer, there had been such a user of the invention in this country as to justify the Court in granting an injunction against the use by the defendants, within that portion of her Majesty's dominions called England and Wales, of any capsules made of a material similar to that described in the plaintiff's patent.

TORR *v.* BRINJES.—REBURNING ANIMAL CHARCOAL.—Trial without a Jury. Before Vice-Chancellor Sir W. P. Wood, March 20, 1867. This was a trial of an issue for the purpose of determining whether the defendant had infringed the patent for "improvements in, and an improved apparatus for, manufacturing and reburning animal charcoal" obtained by the plaintiff in 1862. The defendant had also obtained a patent, and the question resolved itself in effect into a comparison of the two specifications with the aid afforded by other existing patents relating to the same subject-matter. The claim of the plaintiff, as stated in the specification of his patent, dated 27th February, 1862, was "the combination, as above described, of two or more cylinders, each having the thread of an archimedean screw attached to its interior, and also the combination in one cylinder of an inner and outer cylinder, each furnished with an archimedean screw, as set forth in the foregoing description of the lower cylinder, and I also claim as my invention a rotary cooling box in the form of a double drum, as above described."

By his complete specification, filed on the 22nd of October, 1864, the defendant claimed as his invention:—1, The application and use to and in the reburning of animal charcoal of cylinders or retorts provided with a series of internal rings or flanges, in combination with a series of doors or vanes operating substantially as and for the purpose hereinbefore described; 2, the application and use to and in machinery or apparatus for reburning animal charcoal of a rotating cooling drum or chamber provided with an inner or outer skin, and supplied with water for the purpose of more readily cooling its contents, substantially as hereinbefore described. Models of the apparatus used by plaintiff and defendant respectively were produced in court.

Mr. Giffard, Q.C., and Mr. Drewry were for the plaintiff; Mr. Grove, Q.C., Mr. Druce, Q.C., and Mr. G. N. Colt were for the defendant.

The Vice-Chancellor held that the defendant had not infringed the plaintiff's patent. *

REVIEWS OF NEW BOOKS.

FAMILIAR LECTURES ON SCIENTIFIC SUBJECTS. By Sir JOHN F. W. HERSCHEL, Bart, K.H., &c. 1 vol. 8vo. Strahan, London. 1866.

THIS collection, partly of lectures given to parish audiences in schools at Hawkhurst in Kent, partly of papers printed in *Good Words*, &c., bears the general stamp of universality and accuracy of knowledge over the wide domain of abstract science and of nature, which has characterized Sir John Herschel in all that he has accomplished during a long life of scientific labour. Some of the papers, especially those on Light, on Vision, on the Sun, &c., are most charming reading, either to the

* The specifications, with the drawings referred to in this case, are given at p. 42, vol. i., Third Series, *Practical Mechanic's Journal.*

person who is to be taught results, and something generally, as to the way in which they have been got at, or by the man of science who likes to have the results he has already mastered passed pleasantly in review order before him once more. There is but one paper in the volume to which we can take exception; it is the very first, that about Volcanoes and Earthquakes: it is very incomplete, and, we are obliged to say, in some of its statements inaccurate. That we may not venture such an assertion in the case of one so eminent as the author, without showing that we have grounds to support it, we will give one illustration.

At page 15, "Now I come to consider the manner in which an earthquake is propagated from place to place; how it travels, in short. It runs along the earth precisely in the same manner and *according to the same mechanical laws as a wave along the sea*, or rather, as the waves of sound run along the air, but quicker."

Now, this is simply bad science; it is to go back to Mitchell's mistake made 150 years ago, which was completely set aside by Mr. Mallet in his paper on the Dynamics of Earthquakes, read to the Royal Irish Academy, and which fixed the science of that subject as now accepted by all. The confusion between liquid waves, and waves of sound, too, is only calculated to make the ignorant reader more profoundly in the dark.

But the whole of this paper bears evidence of want, on the part of the distinguished author, of his being *au courant* with the existing state of knowledge of the subject, and repeats several statements and views derived from obsolete authorities, or imperfect observations now fully recognized as such. The truth is, however, the subject is one not fitted for a Kentish parish school auditory: to be treated of at all, requires to assume more physical knowledge, and that of a rather recondite sort, than is even always to be found in a popular lecture room audience, who are supposed to be on a much higher level. "Milk for babes, meat for men," here applies. We are not quite sure, either, that Sir John is assuredly right in his notions as to the method of estimation of skill in target shooting.

However, the book as a whole is a very pleasant, instructive, and charming one; beautifully got out by its publishers, and very cheap.

THE HANDBOOK FOR FIELD SERVICE. By Brigadier-General LEFROY, R.A., F.R.S., with the aid of several Contributors. Fourth Edition, revised. 1867. Pocket-book size.

STRICTLY this is not a published work. It is printed at the Royal Artillery Institution, Woolwich, and issued by authority of the War Department for the use of the service, more particularly for that of the scientific corps of the army. Through the obliging favour of General Lefroy, however, we have received a copy; and as a great deal of the matter in the volume is of interest to the civil engineer and mechanician, as well as to the soldier, it is not unsuitable that we should notice the work in these pages.

It certainly is a startling fact, and one not quite agreeable to recall, that while the French, German, Russian, Belgian, and even Spanish armies have long possessed more or less excellent condensed books of this sort, no *aide mémoire* for the pocket of the British engineer or artillery officer existed in our own service up to the year 1854. In that year, for the first time, so crying a want was supplied by General, then Colonel, Lefroy, by the first edition of this handbook, and a very excellent little work he produced at the first blow. The impression was, we believe, exhausted, and in 1857 a second edition was prepared by Colonel, then Captain, Younghusband, R.A. A third and still improved edition was produced in 1862, under the direction of Captain Andrew Noble, late R.A., and now the fourth and latest edition comes forth due to the care and skill of Captain Harrisson, R.A., but still under the supervision of its original creator, General Lefroy.

Of the contents of the volume, so far as we are competent judges, we can only speak with praise. The arrangement generally is good; the matter terse and lucid, and, upon the whole, of indispensable importance at one time or another.

The volume, with its present additions, however, has become rather too big for a very convenient pocket book. Though its dimensions are no more than 5 inches × 4 inches × 1¼ inch, opening pocket book fashion at the end, still its weight is 8 ounces and upwards. With all this the volume is much smaller than either of the corresponding *aides mémoires* of the French service—viz., that for the *corps de génie*, and that for the *artillery*. But these are small though thick octavo volumes, and we have some doubt whether they are meant to be carried into the field generally. The present handbook is so; and a consideration of both its size, and the nature of its contents, has suggested to us whether it might not be with advantage divided hereafter into two parts, putting in the one all, or as much of the whole as possible, that is certain to be needed by the scientific officer in actual warfare in the field; and in the other all the rest of the matter, some of which is rather of the nature of didactic memoranda—reminders of heads of professional study already acquired—more than mere cut and dry handy data. Each part would thus weigh only about 4½ ounces, and for a horseman, whether carried in pockets or in holsters, would be more convenient than at the present thickness. Even that redoubtable rider, John Gilpin, found *two* beer bottles better than one, slung to his belt "to keep his balance true."

Perhaps concinnation might be even yet practised to a higher pressure than has been done with a few pages of the volume. At page 201, for example, where, after the capital section on knots, &c., we have "Relation of Power to Weight," &c.—viz., those relations in the screw jack, elevating screws, gun gins, &c., used in the service—why might not all that, much condensed, go to page 353, amongst the expressions for the common mechanical powers?

Again, why should nearly two pages be wasted on "Practical Hints on Military Landscape Painting," which every cadet ought to have got at his finger's ends before he has left school at Woolwich? No officer, or even artillery or sapper sergeant, should need the table of tints, &c., to be obtained by mixing common water colours (page 244), where, by the way, we observed the only misspelling we saw in the book—CadmiAm for Cadmium yellow. As to this field landscape painting, we may remark as a result of some scientific travelled experience, that five colours will do all that possibly can be needed for military or scientific sketches of scenery for after reference—viz., constant white, Venetian or light red, indigo, Indian yellow, blue-black or lampblack—five in all. Cadmium yellow should never be brought into the field; in a dry climate it cracks and crumbles off the paper even, and does so at once in a tin moist colour box, which is the right tool for the traveller or officer, of a size to go into a waistcoat pocket.

A few, very few, points attracted our attention in the chapters that most nearly touched our own special knowledge as engineers in civil life, as perhaps still needing farther consideration. The roads of France *now* are not "paved with large blocks of stone upon a layer of sand," as stated at page 263, *so generally* as inferable from the passage; on the contrary, a large proportion are now macadamized, and as good as any in England.

Again, on what authority is it said that "quartz and granite should" only "form a substratum for roads, as they are too hard for the feet of horses at the top?" Parts of the Great Holyhead Road, made by Telford, were of quartz rock, and are still so, and work and wear beautifully. Our London roads are of diorite, or practically of granite; and there are no nicer roads in the world than some of the great highways of North Western Normandy and Brittany, all of which are of granite, or of intensely hard and tough quartz rock.

At page 282: "To destroy a suspension bridge, destroy or blow up the points of support to which the cables are affixed." This is surely very imperfect: the mass of the suspension bridges of the civilized world are not of wire cables, but of flat link chains, and to blow up or destroy their anchor plate ends would often be a work of days or weeks. If the bridge be of iron wire cable, drive a few iron wedges into the strands of the cables so as to start off and separate them a little at one point. The strands of wire may then be readily cut with a heavy axe in succession, until the weakened cables give way altogether, dropping the platform with themselves into the river. If the bridge be of flat-linked chain, put a heavy charge of powder upon the surface of the roadway platform, and right across at the middle of the length, and having, if possible, first driven out some of the joint pins of the vertical suspending links thereabouts—fire—the platform will be broken down over a greater or less length. We believe the firing of powder lodged upon top of the chains of the bridge at Pesth, in Hungary, was tried in 1849, and found not to damage the bridge at all seriously.

It is rather as willing helpers than as carping critics that we throw out these hints. As we had occasion on a former occasion to suggest, when noticing a civil engineering pocket book, so we may repeat here that it would be of immense importance if this field book could be printed upon artificial parchment, which will not readily tear, or get

"dog's-eared," and that it should be made waterproof. A soldier in the field can never insure keeping anything that he has about him always dry, and a book on thin paper once saturated, is nearly destroyed or rendered useless.—Ed.

Useful Information for Engineers. Third Series. By William Fairbairn, C.E., LL.D., F.R.S., &c. &c. Crown 8vo, Illustrated, pp. 330. London: Longman & Co. 1867.

This new work, from the laborious pen of William Fairbairn, consists mainly of a series of papers on various engineering, physical, and educational subjects, by the life-long attention to which he has made for himself a reputation more or less world-wide.

It is not at all necessary that we should now speak as to the character of this series of works which Mr. Fairbairn has from time to time sent forth to his professional brethren; the fact of the two first volumes having passed through many editions being quite a sufficient proof of their appreciation, however much all this might have been predicted from the mere distinction the author is fortunate to hold as a leader in certain special branches of the applied sciences.

Mr. Fairbairn's books come before the profession with a special recommendation that few other authors' can command—we may, we believe, safely say no other; for it is unquestionable that no living man has, during the period in which Mr. Fairbairn has lived, deduced so much professional knowledge, not from mere theorizing, but facts—certainties rendered still more certain, being the result of experiments of practical dimensions and on practical subjects. In these remarks we mean no detraction from the great merit due to those who have followed up and extended the several lines of inquiry which Fairbairn now many years ago originated. Prior to his experiments almost nothing was known of the strength of iron, either malleable or cast—indeed nothing certain was known. The experimental inquiries on the strengths of different kinds of iron, steam boilers, bridge building, the gigantic investigations antecedent to the production of the Brittania tubes, those relating to different kinds of rivetted joints, iron shipbuilding, &c.—are each one of them of unexhausted value, as having initiated kindred lines of inquiry, which have been, and are being followed out to more completeness by others; and whilst it is extremely probable, indeed certain, that on many points the profession may have to modify yet the conclusions which Mr. Fairbairn has drawn—still the great merit due to the far-seeing mind by which these investigations were given birth to is in no way lessened.

The present work contains several especially valuable papers—amongst which may be mentioned those on submarine telegraph cables, that on the Atlantic cable, on iron and its appliances, the construction of iron roofs, in which is contained a short review of the history of such structures; all these present themselves to our mind as of great importance and assistance to the practical engineer.

We need not here attempt a further *resumé* of merit which the book possesses, although we cannot avoid drawing our readers' attention—especially those of the pupil class—to the plain-spoken domesticated modesty with which the author, at occasional intervals throughout his lectures, tells us of the difficulties he has encountered, and the modes by which through long-continued perseverance they have been overcome, the path indeed he has trodden on his road to eminence. There is, however, much in this last volume, indeed most of its contents, that has been said a thousand times before, and often said better. Mr. Fairbairn will make a grave error against his own future fame if he mistakes quantity for quality in what he leaves in type after him. Already there has been far too much repetition, and dishing up again of "funeral baked meats." Each volume of latter years has been more dilute and unimportant than its predecessor—best cease before men call out *crambe biscocta*. Washy lectures to Lancashire local societies of working men, &c., that have done their duty and had their day, will but detract from a name that deserves honour.

Mr. Fairbairn has now arrived at that time of life at which the labour of most men is over. Let us, however, look forward to see him still active among us for many years yet; while enjoying, too, the fruits of labour which he has so well earned, *Otium cum dignitate*.—V. D.

Lecture Notes for Chemical Students, embracing Mineral and Organic Chemistry. By Edward Frankland, F.R.S., For. Sec. C.S., Corresponding Member of the Imperial Institute of France, Professor of Chemistry in the Royal Institution of Great Britain, and in the Government School of Mines. (Van Voorst.)

"Chemistry is the science which treats of the atomic constitution of bodies, and of those changes in matter which result from an alteration in the relative position of atoms."

Such is Dr. Frankland's definition of chemistry. We venture to affirm that chemistry is nothing of the sort, and that this is a definition, not of chemistry, but of that farrago of hypotheses, which is sought by a certain school at present to usurp its sovereignty in place of continuing its handmaid. Chemistry is the science of the sensible qualities of material bodies, other than those merely related to mechanical force, and even this comes into play often, to modify the chemical forces, upon which sensible qualities depend, and *the nature of which remain utterly unknown*. Chemistry has discovered no laws, but those simple ones as to combination, expressible in three sentences, and which, dimly shadowed forth by Richter and Higgins, were fully discovered and made known by Dalton. Upon these three simple laws, reducible indeed to one, as being those alone whereby any of its phenomena are brought within "the grasp of the computist," and referable to number, really rests its entire claim to be ranked as a science at all, or anything more than a system of observation of facts as to sensible qualities.

It has always been the characteristic of a time of dullness and inactivity in the onward path of genuine and laborious science, in every department, that complicated hypotheses and cumbrous nomenclature make their appearance and are thrust into daylight in the garb of science. But the only real effect of such *simulacra* is to delay the advance of knowledge, and be after a time forgotten.

Atoms, molecules, atomicity, monatomics, and hexatomics have no provable existence, nor has anything of the slightest value been added to them as hypotheses since the days of Dalton, the realistic and truth-loving natural tendencies of whose mind, caused him to discern how small a way they can carry us onwards towards real discovery, and yet who even himself pushed their use something beyond what was warranted. After Dalton's day, and for many years, during which the domain of chemical facts was enlarged by the prodigious mass of brilliant discoveries made by many great men in every quarter of Europe, with Berzelius at the head, who had the Newtonian scorn for figmental hypotheses, atoms and molecules remained dead and unnoticed almost. The chemists of the first half of our century were content to strive before the balance, laboriously to connect by *numbers* the realities of the qualities they observed and examined in material substances, without pretending to have got any key to deeper secret chambers in the world of matter by the creation of a cloudy mass of names. But later, the old vicious retrogression from reality has got possession of a certain school of chemists here and abroad, who have made further assumptions, hypotheses, and complications upon these old notions about atoms and molecules, and would really persuade us that they have discovered or can explain something by this—*βρηκεκεκαξ κοαξ κοαξ*, the key note of all of which is as old, if not older, than Pythagoras.

Dr. Frankland's book pushes this to its extremity, beyond which the force of scientific fancy can scarce go. From it, though called "Lecture Notes for Chemical Students," the student will scarcely collect a single fact of the science; but he will find in place of this a labyrinth of symbols and pictures of imaginary coalescences, and combinations of imaginary atoms and imaginary molecules, some of which in their complication are absurd even to the eye, more like a pattern for Berlin wool work than anything else, as one reviewer says—all which, if he do not possess by nature a scientific head, will confound, and should he have a scientific head, *i.e.*, a love for truth and a power to pursue it in nature, will simply disgust the student.

But British chemistry, in a certain school of it, has not deemed all this enough: it has also done its best to introduce a new and ridiculous nomenclature, and to oust that which is well known and has done good service all over the world from Berzelius' day. Were we to attempt briefly to describe in what this new nomenclature consists, we might say, chiefly in turning all old names upside down. Before the outer vulgar, the use of such dissonant stuff may have its use, *omne ignotum pro magnifico;* but for those who know the facts, through the language of the long-accepted nomenclature of Europe, and can therefore trace

what is intended to be conveyed in this new macaronic language of chemistry, it is hollow and useless: it explains nothing, it clears nothing. Who could fancy what a *crith* means? or guess that because κριθή, from which it comes, means an ear of barley, so a *crith* means the weight of the unit measure (1 cub. decimetre) of hydrogen? How highly suggestive, how classically chemical, and chemically classical! but let that pass, as a name for one thing, which once known is always to be used. But what shall we not expect in the way of discovery from hypotheses and nomenclature that engender and bring forth such beauteous offspring as the following samples of the family, taken out of the volume at random:—

Talc, *Tetrahydric pentasilicate*—its name.

$$\left.\begin{matrix} SI.Ho_2 \\ O \quad Cao'' \\ SI \quad Ho_2 \end{matrix}\right\}$$ its formula.

and its *figure*, that is, the *picture* of the edifice into which its imaginary atoms are built up, drawn and engraved (it reminds one of the Irish schoolmaster *drawing out upon his slate* the meaning of the word Ptysick, which was too hard to define in words), but which for want of a copperplate we cannot show, is represented by twenty-three circles, coupled together Berlin-wool fashion, and each with his appropriate initials on his breast. Or let us take

Felspar, *Dipotassic aluminic hexasilicate.*

But these are nothing; here is Fahl. ore of antimony, *i.e.*, sulphide of antimony, iron, and copper—

Sulphocuprosoferrous pyrosulphantimonite.

No better proof of the worthlessness of all this fuss about atomicity and molecules is, that when taken in procession through the whole walk of chemical fact, it utterly breaks down in explaining *all* the observed facts. There is no surer test than this of the truth to nature, or the contrary, of any hypothesis, if it cannot explain *all* the phenomena as they present themselves, leaving none out, nor requiring the existence of facts or phenomena that don't exist and cannot be made to show themselves, then is it false essentially; whereas, if an hypothesis be true, that is, if it represent nature, it and every fact it can be brought into contact with, will go together like the pieces of a dissected map—leaving no vacancy, having no redundant piece. For example, Dr. Frankland's hypotheses oblige him to double the formula for nitric oxide, NO, as otherwise nitrogen being combined with his diatomic oxygen, must itself be diatomic; but this doubling then conflicts with the long-established law of gaseous volumes. Out of this dilemma Dr. Frankland,

> "Who can the difference see
> 'Twixt tweedle dum and tweedle dee?"

tries to extricate himself and his atomicities, by supposing that although the true formula is N_2O_2, yet the body is dissociated into two groups of NO — NO at all ordinary temperatures. Now if this be not a chemical sophism logic has deserted us; for if any such dissociation have taken place, either each separate molecule must still contain diatomic nitrogen, and if so the dissociation goes for nothing, or it does not, and in that case the nitrogen is monatomic, that is, it is our old friend of Berzelius and Wöhler's day after all. Woe be to those who darken counsel by *words* without knowledge.

The time has more than come when such chemists as are left amongst us in Great Britain, and who regard facts and knowledge before wordy illusions and pretence, those of the school that produced Graham, Herschel, and Faraday, should give utterance to their opinion as to whether knowledge is to be retarded by the unnecessary confusion of a known and sufficient nomenclature with a new, rugged, and uncouth one, destitute of any apparent advantage of any sort. As to the atoms and molecules, there is no need to be troubled about them. Like every such unstable and baseless castle in the air they will drop down into the pool of oblivion, like all other unrealities, of their own accord.

Ours is not an exclusively chemical journal, or we might pursue the subject to somewhat greater length, and show how completely powerless the whole molecular and atomistic apparatus becomes, when taken into the range of organic chemistry, where, if anywhere, when dealing with the endless sensible qualities of substances in a world all made up of only four or five (so called) simple elements, we ought to find it a guide, and as a light shining in a dark place, but in which it proves none.—Ed.

The Reign of Law. By the Duke of Argyll. 1 vol. 8vo. Strahan, London. 1867.

This is a very remarkable book, and is certain to be as popular a book as one upon such subjects can be, in these days of novel reading. It is remarkable as being written by a duke, and for comparing in a highly favourable manner with such achievements of that great British "order" as are most frequently noted and journalized—say, laying in a private electro-telegraph in order to be able to attend in fireman's scales and helmet at London fires, or, *me-hercle*, bagging sixteen hundred head of game in a week. It will be popular, and, we believe, is already so, not merely because the newspapers, from the *Times* to the *Saturday*, have been most polite to philosophy shedding down its radiance from "high places," but because it is "orthodox;" orthodox after the fashion above all others that a large class in Great Britain longs for above any or all others, namely, an orthodoxy that with profound expression of reverence for the accepted credences, or what are taken for such, in our British forms of Christianity, goes to work with an appearance of rough-handed and muscular daring to prove that these and all these, just as they stand in each and every one's mind, are perfectly reconcilable with all that science truly, *i.e.*, not falsely so called, teaches—to show, in a word, from a sufficient (not to say ducally-elevated) point of superior sight and knowledge, that the certitudes of science and the dogmata of theology are perfectly reconcilable, or rather have nothing really to reconcile between them. For another reason the book will be popular, because it is very readable by the class of people who will chiefly ask for it, It is stuffed full of illustration and instance, borrowed from almost every region of physical science and of natural history.

We are reluctantly obliged to confess, however, that the resulting impression made upon our minds after going through the work is, that it is far from being a profound or really philosophical production; and that it is one which, after a good deal of parade of knowledge, does not advance the subject—if it can be said to have a subject, that is, any one single thesis to be proved—one jot beyond the position in which it has been long since left by far deeper thinkers and sharper logicians than the author.

The volume consists of a compilation of essays, partly written for the *Edinburgh* or other reviews, partly delivered before the Royal Society of Edinburgh. Though these are now tagged together in a way to form a sort of connected whole, there is but a slender clue of reasoning to carry on by them, any one train of thought from the opening to the end of the volume. Besides this, such argument as does pervade the book, as a whole, is often obscured, and the thread lost for a time, if not wholly, by the perpetual lugging in of illustration and instance. However the variety of these, and the multiplicity of the sources from which they are drawn, may serve to show the author's wide and diffuse, if not particularly deep reading, they are frequently, to our view, singularly ill chosen, and convey the idea of an overflow rather than a choice of information. To take one illustration, p. 99: "No one law, that is to say, no one force, determines anything that we see happening or done around us. Recent investigations in physiology seem to favour the *hypothesis* that our muscles are the seat of two opposing forces, each so adjusted as to counteract the other, and that this antagonism is itself so arranged as to enable us, by acting on one of these forces, to regulate the action of the other. One force, an elastic or contractile force, is supposed to be inherent in the muscular fibre; another force, that of animal electricity in statical condition, holds the contractile force in check, and the relaxed, or rather the restful condition of the muscle when not in use is due to the balance so maintained. When through the motor nerves the will orders the muscles into action, that order is enforced by a discharge of the electrical force, and upon this discharge the contractile force is set free to act, and does accordingly produce the contraction which is desired." For all this wordy nonsense the lectures on epilepsy of Charles Bland Radcliffe, M.D., are referred to, his theory of muscular and nervous action as thus set forth being declared to have been set forth "with much ingenuity and force of illustration."

The leading thought, if, as we have said, there *be* one, of the work, is to prove that the Reign of Law pervades the universe, material and moral; though what is the exact sense in which the author uses the term "law" is never, to us at least, made quite clear, and although in the chapter on "Law, its Definition" no less than five senses in which it is said to be commonly employed are said to require to be accurately distinguished. However, we arrive at the general notion that the author's meaning of the reign of "law" is, in fact, identical

with the sense in which the German philosophers, as well as men of science (natural and physical), have long employed the word; the cosmos—that is to say, an ordained and immutable order of the universe, seen and unseen—of sense and of mind viewed, as a whole, to the utmost bound we can know it, and as derived from our observation and interpretation of the phenomena. Upon this he undertakes to graft as not inconsistent, *i.e.*, as an intellectual possibility, the theological doctrines of special providences, miracles, &c.—in a word, of the perpetual voluntary interference of the first cause or admitted creator of the whole; nay, what is even harder "to thole," as his grace's countrymen would say, of the perpetual voluntary interference of man himself, who is thus no longer the humble "*minister et interpres naturæ*" of Bacon, but a co-creator with the author of nature himself. "It is a mere confusion of thought and of language which confounds the invariability of laws, either moral or material, with the denial of the power of will to vary, alter, and modify in infinite degrees the course of things. It is the fixedness of all forces in one sense which constitutes their infinite pliability in another. It is the unchanging relation which they bear to those mental faculties by which we discover them and recognize them, that renders them capable of becoming the supple instruments of those other faculties of will, of reason, and of contrivance by which we can work them for altered or for better purposes."—p. 353. Again—"Men have been right, and not wrong, when they saw in the facts of nature the variability of adjustment even more clearly and more surely than they saw the constancy of force. They were right when they identified those phenomena with the phenomena of mind. They were right when they regarded their own faculty of contrivance as the nearest and truest analogy by which the constitution of the universe can be conceived and its order understood. They were right when they regarded its arrangements as susceptible of change, and when they looked upon a change of will as the efficient cause of other changes without number and without end." "It is an unspeakable comfort that when we come to close quarters with this vision of invariable law seated on the throne of nature we find it a phantom and a dream, a mere nightmare of ill-digested thought and of God's great gift of speech abused."—p. 434. So, behold the end of the whole matter! It is really not easy to catch what these passages and the general drift of the book, of which we admit they give but a most imperfect idea, aim at or mean at all, to be plain, in connection with all the rest. But what we gather is this, that either man, the "minister and interpreter of nature," when he employs fragments of the forces he finds in play in the cosmos, so far forth as his knowledge of them goes, for his own purposes and in answer to his own volitions, in doing so alters the otherwise train of the phenomena, and by doing so introduces a change of law into the universe, and that God acts in the same way; or that will (human will) is a force in itself distinct from and independent of the rest of the universe, into which, whenever it acts, it introduces a new and extraneous force, which modifies in a way that defies prediction all other forces. In either case, as it appears to us, there is an end of the cosmos. Curious philosophy this—but we have no place here to discuss it at the length and in the way alone of any use. Let us, however, just ask the noble author this. If the *whole* cosmos be bound up in law, *albeit that that law be ever so variable, provided it be law at all*, how is any meddling or tinkering after it has been once established possible? If every sub-law, the whole of which together are the cosmos, be expressible (as every *law must be*) by a curve of some sort, no matter how much every such curve may prove some law of *change or of variability in the law itself*, no matter how continual or how complex, then must not the intersections and mutual relations of all these curves, at all their length, be fixed and known and immutable to Him who knows the laws of the whole and who ordained them? Where, then, is there room for the introduction of extraneous forces, themselves not subject to law? If there be human volitions, then by hypothesis they are part of the cosmos, or they are not; if not, they cannot affect its laws, if they are, they can only make use of them in any case. If there be continually new and active divine volitions, then is there no cosmos, but a continued meddling of special providence, the absurdity of which Whately sufficiently showed when he said, that as all natural law and its phenomena are providential, so a *special* providence is to assume a providence more special than a special one. If there be also active, new, and continually recurrent and innumerable human volitions too, then may the noble duke use in a new and wonderful sense the text "Have I not said ye are gods."—Ed.

The Logic of Chance: An Essay on the Foundations and Province of the Theory of Probability, in especial application to Moral and Social Science. By John Venn, Fellow, Gonville College, Cambridge. 1 vol. 8vo. Macmillan. 1866.

The object of this able work is to point out that probability is not, as very commonly it is treated, a mere branch of mathematics, but that it is a branch of the general science of evidence, which may or may not employ mathematics in the treatment of its problems, but which has certain classes of problems capable of ascertainment, but not by mathematical methods.

The chapters on Fallacies, on the Credibility of Certain Stories, on Causation, and on Statistics as applied to Human Action, are of great merit. The whole work will reward the reader who loves to reach principles. It is not quite in the way of *our* readers, though directly concerned in social and other problems which have an equal interest for all.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

THE INSTITUTION OF CIVIL ENGINEERS.

ON THE WORKING OF STEEP GRADIENTS AND SHARP CURVES ON RAILWAYS. By Captain H. W. Tyler, Assoc. Inst. C.E.

It was remarked that the comparative terms, steep and sharp, had acquired at the present day a signification very different from what they conveyed to engineers a few years since. The locomotive engine had been gradually trained and adapted to gradients of 1 in 100, 1 in 50, 1 in 25, and 1 in 12, combined with curves of from 30 chains down to 15, 10, 5, and even 2 chains radius; and during all this progress, the result of so much labour and ingenuity, the system of bite, or adhesion, by plain surfaces, had steadily triumphed as a means of converting steam-power into tractive force. The co-efficient of adhesion was always in the first instance under-estimated; and the central rail system, first patented by Mr. Vignoles (M. Inst. C.E.) and Mr. Ericsson, on the 7th of September, 1830, was intended to provide extra adhesion on what were now considered moderate gradients, in place, apparently, of the well-known rack-rail of Blenkinsop.

In conveying heavy loads up gradients much less steep than several which had been worked, for a greater or less number of years, with engines of ordinary construction, a want of extra adhesion had been seriously felt, and various expedients had been resorted to for obtaining it. M. Flachat proposed, in constructing railways over the Alps, to utilize the adhesion not only of all the wheels of the engine and tender, but also, by the use of additional cylinders, &c., to them, of all the vehicles composing a train. Mr. Sturrock had added cylinders and the necessary apparatus to the tenders, and employed them for some time as assistant engines on certain parts of the Great Northern Railway. M. Thouvenot, on the Continent, and Mr. Fairlie, in this country, combined two tank engines in one, placed, as it were, back to back, and united as to their boilers and fire-boxes.

In the ordinary system of obtaining adhesion by bearing wheels only, whether of an engine and tender, or of a double engine, or of two engines coupled together, the weight of the motive power required to be increased for a given amount of adhesion, in proportion to the load or to the steepness of the gradient. The limit of the gradient up which such an engine could take a load might roughly be defined by the co-efficient allowed for adhesion. Supposing this to be one-tenth, then 1 in 10 was (omitting friction) the gradient on which an engine might move itself, but on which no load could be taken. As on the railway over Mont Cenis, the adhesion might vary from one-sixth to one-twelfth, and as gradients were required of 1 in 12, it was necessary to adopt some other method than that of trusting to adhesion by bearing wheels; and having a high summit to surmount, it was of great importance, with reference to cost of working, to save weight in the engine as well as in the trains. By adopting the principle of horizontal wheels and a central rail, Mr. Fell (Assoc. Inst C.E.) found the means of doubling the adhesion, at the same time that by the use of steel, the engine was made lighter than it could otherwise have been. This principle was first tested, experimentally, on the Cromford and High Peak Railway; and subsequently on a line, 1¼ mile in length, laid on the road over the Mont Cenis, with an average gradient of 1 in 13, containing curves with radii varying from 4 to 2 chains. The gauge was 3 feet 7⅜ inches (1·10 mètre), and the middle rail was laid on its side horizontally, at an elevation (to its centre) of 7½ inches above the bearing rails. The engine constructed specially for the Mont Cenis was partly of steel. Its weight was now 14 tons, and its mean weight, when fully loaded with fuel and water, 17 tons, of which 2 tons 13 cwt. was for the machinery connected with the horizontal wheels. There were only two cylinders, each 15 inches in diameter, with a length of stroke of 16 inches, which worked both the four coupled horizontal and the four coupled vertical wheels, all 27 inches in diameter. The wheel base of the vertical wheels was 6 feet 10 inches, and that of the horizontal wheels was 2 feet 4 inches. The pressure upon the horizontal wheels could be regulated by the engine-driver at pleasure from the foot-plate. This pressure was applied through an iron shaft, connected by means of right and left handed screws with a beam on each side of the middle rail, and these beams acted upon volute springs, which pressed the horizontal wheels against that rail. The pressure employed during the experiments was from 2½ to 3 tons on each horizontal wheel, or 10 tons altogether; but the pressure actually provided for, and which might, when necessary, be employed, was 6 tons upon each, or 24 tons upon the four horizontal wheels. The vertical wheels were worked indirectly by piston rods from the front, and the horizontal wheels directly by piston rods from the back of the cylinders. The results of the different experiments on the Mont Cenis Experimental

Railway were given in several tables, which showed that considerably more could be accomplished than had been proposed in the programme handed to the French and Italian governments. During the official trials, in the month of July, 1865, before the French, Italian, and Russian government commissioners and others, with a load of 24 tons, exclusive of the engine, the distance run in fifteen trips was 51·040 kilomètres (31¾ miles, nearly) at an average speed in ascending of 10·704 kilomètres (6·65 miles) per hour; while with a load of 16 tons, the distance run in eight trips was 29·12 kilomètres (18·09 miles), at a speed of 15·6 kilomètres (10 miles nearly) per hour. During these twenty-three trips the pressure of the steam increased 500 lbs., or 21 lbs. on the average for each run. In the month of November, 1865, when some other trials were made, a maximum speed was attained of 12 kilomètres (7·46 miles) per hour, with a load of 24 tons, and of 18 kilomètres (11·2 miles) per hour, with a load of 16 tons. As evidence of the power of the breaks, it was stated that when the ordinary and the central rail breaks were combined, with a gross load of 41 tons, descending a gradient of 1 in 12, at a speed of about 6 kilomètres per hour, the train was stopped within 20 mètres; while, under similar circumstances, a gross load of 33 tons, at a speed of about 12 kilomètres per hour, was stopped in 20 mètres. It was remarked during the later trials, that the engine and train gained speed on the sharpest curves. This effect, so contrary to general practice, was produced, partly by the action of the horizontal guide wheels, which kept the engine and the wagons in their proper positions with respect to the rails, and partly to the fact that the gradients on the curves had been slightly eased, while the gradients on the straighter portions had been made proportionally steeper, with the intention of as nearly as possible balancing the resistances.

Another system for working steep inclines—that of Signor Agudio—had found support in Italy. In it two stationary engines were employed, one at the summit and the other at the bottom of an inclined plane, which acted upon the same double endless rope, kept stretched by a tension wagon hanging upon it at each extremity. This rope ran between the rails, and over two sets of wheels worked by the stationary engines, from which it received its movement by friction. It did not act directly upon the train, but was connected with an engine, called the "locomoteur funiculaire," supported on a bogie frame at each end, and carrying a system of drums and wheels, by the action of which the required motive power was obtained indirectly by the moving rope. Experiments tried with this system on the Dusino incline between Turin and Genoa in August, 1863, appeared to have given great satisfaction to the commissioners of the Royal Institute of Lombardy. But the author was inclined to think, that neither this system, nor any other yet developed, could compete with the central rail system for general traffic on gradients up to 1 in 10 or 1 in 12.

For mountain passes the author believed the middle rail system possessed great advantages. Besides being of service in the ascent, it afforded the means of employing pressure breaks, acting with any amount of force, to any number of vehicles, and thus rendered the descent safe, and supplied a remedy against bad consequences from a fracture of the couplings. It also prevented the engines, or any vehicles of the train that were supplied with guide-wheels, from leaving the line, from a defect in the permanent way or rolling stock. A country which required very steep gradients demanded also, in most cases, very sharp curves; and the central rail contributed to safety as much in respect to the latter as to the former. On the Mont Cenis Experimental Railway, the bearing wheels of the engine left the rails on two occasions, and on both they were brought back to the rails by the guiding power of the central rail. As, however, in the course of about three months, the line was expected to be opened from Susa to Lanslebourg or Modane, and in from five to six months from the present time throughout its whole length of 48 miles between St. Michel de Maurienne and Susa, there would then be an opportunity of becoming better acquainted with this plan.

It was announced that the discussion upon Captain Tyler's Paper, on "Steep Gradients and Sharp Curves on Railways," would be continued at the next meeting, Tuesday, March 12, when, if time permitted, the following Paper would be read, "Memoir on the River Tyne," by Mr. W. A. Brooks, M. Inst. C.E.

At the monthly ballot the following candidates were balloted for and duly elected:—as members—Mr. Amias Charles Andrews, Resident Engineer of the New Dock Works, Leith; Mr. Henry David Furness, Locomotive Superintendent of the Riga-Dunaburg and Dunaburg-Witepsk Railways; Mr. Robert Edward Johnston, Engineer of the Shrewsbury and Hereford, Shrewsbury and Wellington, and Shrewsbury and Welshpool Railways; Mr. William Jarvis M'Alpine, New York; and Mr. Allan Wilson, Westminster: as associates, Mr. Horace Bell, Executive Engineer, Public Works Department, Bengal; Mr. Francis Bramah Gilbertson, South Eastern Railway of Portugal; Mr. Spencer Herapath, Kensington; Mr. George Houghton, Resident Engineer on the Berlin Gorlitzer Railway; Mr. Charles Harlowe Lowe, Assistant Surveyor of St. Marylebone; Major William Palliser, Army and Navy Club; and Mr. Edward Pritchard, Surveyor to the Local Board, Bedford, Lancashire.

THE ASSOCIATION FOR THE PREVENTION OF STEAM BOILER EXPLOSIONS.

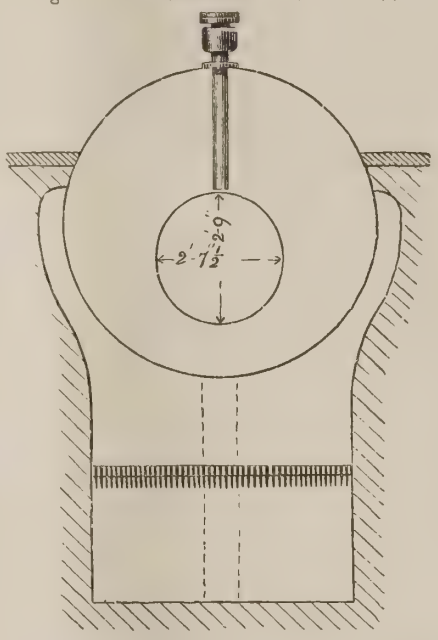
THE monthly report of the Association appears to be successively improving in the value of the information therein communicated to the members. The following abstract will be of great interest to most of our readers:—

"No. 2 Explosion, which happened to a boiler not under the inspection of this Association, occurred at a forge and rolling mill, at about seven o'clock on the evening of Wednesday, January 2, and resulted in the death of one person, as well as in serious injury to two others.

"The boiler, which was externally-fired, and had a flue tube running through it from one end to the other, was set in a somewhat peculiar manner. The fire grate was placed underneath it, but the flames did not pass over a fire bridge at the back of the furnace in the usual way, but escaped from the front, passing directly to the internal flue tube, so that the furnace end of the flue tube was exposed to a more severe action from the flames than it otherwise would have been, which it is important to notice in connection with the manner in which the boiler failed, and which is described below.

"The length of the boiler was 32 feet, while the diameter in the shell was 6 feet 6 inches, and the thickness of the plates $\frac{7}{16}$ths of an inch; the internal flue tube measuring 2 feet 9 inches vertically, by 2 feet 7½ inches horizontally, and being made of plates fully $\frac{3}{8}$ths of an inch in thickness. The boiler was fitted with two safety-valves, loaded to a pressure of about 50 lbs. per square inch, one of them being adapted for relieving the pressure of steam on the water's falling below the desired level, while there was also a glass water gauge and float. It is important that it should be pointed out that the arrangement for the introduction of the feed was very injudicious; the water, which was cold, being delivered by means of an internal feed pipe immediately on to the crown of the internal flue tube, and at a ring seam of rivets but 6 feet from the front end of the boiler, and thus at the hottest end of the tube.

Fig. 1.—TRANSVERSE SECTION AT A—B.



"The boiler gave way in the internal flue tube, which collapsed laterally from one end to the other, the sides flattening and coming together, and at the same time fracturing at some of the ring seams of rivets in consequence of the buckling action of the plates, while the tube was completely severed in two at the seam already described as situated 6 feet from the furnace end of the boiler, and immediately beneath the internal feed pipe.

"The original construction of the boiler, as well as its subsequent distortion in consequence of its failure, will be better understood on reference to the accompanying drawing. Figs. 1 and 2 show the original construction of the boiler and the mode in which it was set, with the furnace placed beneath the shell, and the flames passing directly into the internal flue tube, while at the same time they show the position of the internal feed pipe, which shot the cold feed water immediately on to the hot crown of the internal flue tube, at the ring seam of rivets 6 feet from the furnace end. Figs. 3 and 4 show the tube in its collapsed state, and severed in two at the ring seam of rivets already referred to.

"The explosion was mainly due to the weakness of the internal flue tube, which was badly constructed in the first instance, being an inch and a half out of the true circle, the vertical axis being greater than the horizontal one, so that it collapsed at the flat sides. Added to this it was not strengthened as it should have been by encircling hoops, flanged seams, or water pockets, &c., &c.; while, in addition, the introduction of the cold feed water immediately over the crown of the flue tube, and at the hottest end, had a most weakening effect, not only by eating the plate almost through, as it had done, but also by inducing irregular contraction, which seems to have been the immediate occasion of the collapse, since it occurred the moment after the feed had been turned on by the poor fireman who was killed by the explosion.

"This explosion clearly shows the importance of competent independent inspection. Many boiler makers evidently are quite ignorant of the danger of turning out oval flues in the place of round ones, and at the inquest the maker stated that he approved of the principle on which the exploded boiler had been constructed, and considered the flue, though proved to be an inch and a half oval, yet, to be practically circular. The defects in this boiler would certainly have been detected by competent inspection in time to prevent the explosion.

"FATAL HOUSEHOLD BOILER EXPLOSIONS.

"In addition to the explosions already reported as having occurred to steam boilers employed for manufacturing purposes, six others may be mentioned, which happened during the frost in the month of January to boilers in household use, and set in the greater number of cases in kitchens. These explosions were attended with very fatal results. Thus: The first occurred on January 2, and by it one person was killed, as well as another injured. The second on January 3, by which one person was killed. The third on January 6, one person killed. The fourth about January 9, one person killed, as well as three injured. The fifth about January 17, no one injured. The sixth on January 19, one person killed. Total: six explosions, five persons killed, and four injured. Considering the number of these explosions, as well as their fatality, little apology is required for referring to the subject, especially since those most exposed to injury are domestic servants, totally ignorant of the danger incurred, and so many of them appear to suffer from these explosions on the recurrence of every frost, and will, it is feared, continue to do so as long as the present construction of these boilers continues unaltered.

"It is reported that all the exploded boilers just referred to were on the circulating system, and although a personal examination has not been made, yet it is thought

that the construction generally adopted in these boilers affords an easy explanation of the frequency of their explosion. These circulating boilers are for the most part constructed with an overhead cistern connected to them by means of two pipes, so

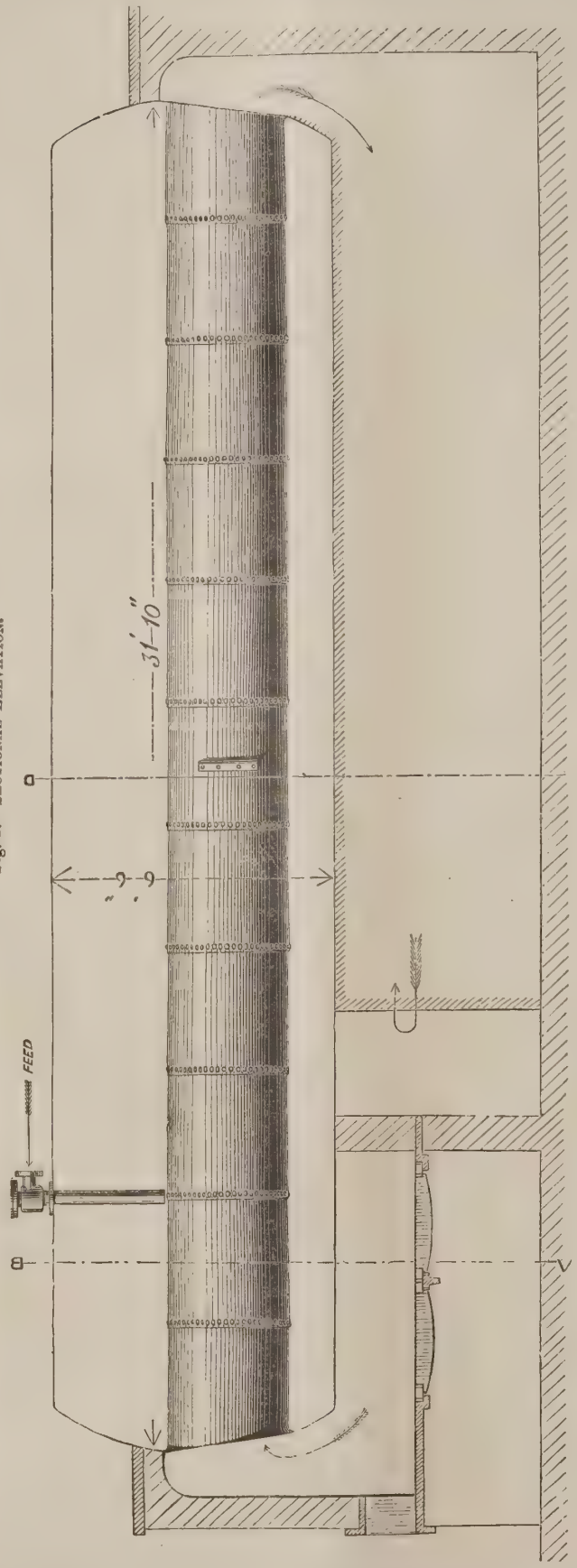


Fig. 2.—Sectional Elevation.

that when the fire is lighted the steam and heated water rise through one of these pipes, and the colder water, from its superior gravity, descends through the other, and thus a regular circulation is set up, which continues as long as the pipes are free, the supply of water is kept up, and the fire burning. No arrangement can be safer as long as these conditions are complied with. The surplus steam finds a free escape from the overhead cistern, while the two open columns of water form two natural safety-valves to the boiler, and entirely forbid any pressure within it beyond that due by gravity to their height, so that there is no more pressure within the boiler when the fires are burning, however brightly, than when the water is quite cold. It will readily be seen, however, that if the thoroughfare through the two connecting pipes were at any time to become closed, the conditions would be altogether altered, and the steam having no longer any outlet, the pressure would inevitably accumulate within the pipes and boiler. This is just what takes place on the occurrence of a frost. The circulating pipes become choked with ice, when the pressure is bottled up within the boiler, so that if the fire burns brightly enough to raise the pressure to the ultimate strength of the plates, explosion must necessarily ensue, and the more hot water contained in the boiler, the greater its force. These explosions, therefore, are attributed simply to excessive pressure, and to prevent this it is recommended that every boiler should have fixed to it a metallic safety valve, which, being unaffected by changes of temperature, would come to the rescue when frost sealed the other outlets.

"It may be added that should the water supply at any time run short, whether from frost or from being suddenly cut off by the water company, it might be well to withdraw the fire before the boiler can be run dry and overheated; not that it is thought that such serious consequences would result from the sudden re-introduction of the water as it is very generally supposed, but the boiler, if heated, might be seriously strained and injured, though it is questioned if it would be destroyed. It may easily be ascertained whether the boiler is supplied with water or not, by opening a test tap on the circulating pipes.*

Fig. 4.—Ground Plan.

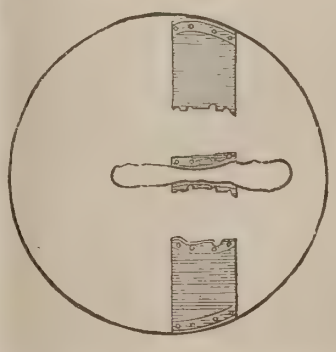


Fig. 3.—Transverse Section at C D.

* "Since the above was in print the views therein expressed have been corroborated by practical experiment, which showed that the danger of injecting water into red hot boilers has been greatly exaggerated. These experiments were conducted on Saturday, the 2nd ultimo, and I am indebted for the means of carrying them out to the kindness of Messrs. Isaac Storey and Son, of Manchester, who provided me, at their own expense, with three boilers, at the same time affording the assistance of their workmen, with all necessary appliances and the convenience of their premises, on which the experiments were conducted. As the question involved is one of very general importance, relating not only to the safety of

"The importance of attaching these safety-valves to all household boilers was pointed out in the Association's Monthly Report for January, 1865, in consequence of which a few valves were fixed; but from the number of fatal explosions during the recent frost, it occurred to me that further service would be rendered by giving a sketch of a simple safety-valve specially adapted for the purpose, accompanied by a description, and, therefore, a drawing has been worked out for this purpose as shown in fig. 5. This gives a full-size vertical section of the safety-valve, recommended on account of its simplicity, which is a miniature adaptation of a valve in very satisfactory use on many of the large steam boilers under the inspection of the Association. It is of external pendulous dead-weight construction, the seat of the valve being spherical, and without either guide fangs or spindle, so that there is nothing to interfere with its free action or impede the thoroughfare. The central hollow pedestal on which the valve seats is of brass, as well as the external cylindrical shell which drops over it, and contains the valve itself, while the weight is simply a ring of lead. The area of the opening at the valve seat is a quarter of a square inch, so that every pound weight on the valve gives a pressure of 4 lbs. on the boiler, while 45 feet is the total head of water which the valve shown is calculated to balance. It is important that these safety-valves should not have a greater load on them than that due to the head of water, as many of the boilers are not strong enough to bear it, and therefore the safety-valves will require different loads for different positions. The proportions of the shell and dead weight have therefore been arranged for easy calculation, the shell being adapted for a constant head of 10 feet of water, and the lead weight for a head of 35 feet, which is equal to 10 feet for each inch measured upon it vertically, since it is $3\frac{1}{2}$ inches high. Thus, with the lead weight as shown, the valve is adapted for a column of 45 feet; with a weight 3 inches high, for a column of 40 feet; with one of 2 inches, for a column of 30 feet; and 1 inch for a column of 20 feet; while, should the valve be required to balance a column of greater height than 45 feet, the lead weight could easily be increased either in height or diameter.*

"The position of the valve, and the mode of fixing it to the boiler, must depend upon convenience in each instance. It is shown in the drawing with a wrought-iron flange, attached to the valve with a screwed nipple, and which can be secured to the boiler by bolts tapped into the plate. This may be convenient in some cases where the valve can be planted directly on the top of the boiler; while in others, it may be better to fix it with a short pipe, which can be curved or not as required. In one already fixed, the brickwork above the boiler was recessed, and the valve placed in the niche, being covered in out of harm's way by a small cast-iron door, fitting into a cast-iron frame driven into the brickwork. This valve was fixed in consequence of the frost in January, 1865, and has not been found to give any trouble from leakage or otherwise.

"With regard to the cost of these valves, it appears, from an estimate obtained from a brassfounder, that they can be made for about 10s. each, while, if applied to boilers already in use, the connection would probably cost 5s. for material, and another 5s. for labour, making about £1 in all; but if the boilers were adapted for them when first made, and the valves fixed at the same time, they could be turned out complete for about 10s., so that it will be seen the expense is inconsiderable.

household boilers, but also to the explanations so frequently given of the cause of explosions occurring to large steam power boilers, it is thought that the details of the experiments would prove of interest.

"Three different boilers were experimented on, all of them being of the ordinary household circulating class.

"The first of these boilers was made of copper, weighed 62 lbs., and measured $14\frac{1}{2}$ inches in height, $11\frac{3}{4}$ inches in width, by $13\frac{3}{4}$ inches in depth at the bottom, and about 8 inches at the top, which gave an internal capacity of 1 cubic foot as nearly as may be. This was placed, when perfectly empty, on the top of a briskly burning fire, as well as surrounded with it, and allowed to remain so for a considerable time, till the bottom became thoroughly red hot, and lumps of lead freely melted though but loosely laid on the top, which was the coldest part of the boiler, being out of the reach of the flames. When the boiler was in this condition, water was suddenly let into it through a pipe about $\frac{1}{2}$ an inch in bore, connected to the Water Company's main. No explosion, however, took place, the boiler was not stirred from its seat, neither did it tremble or evince the slightest signs of internal commotion; all that took place was a rush of steam through an outlet $\frac{7}{8}$ths of an inch in diameter, left on the top of the boiler. It was necessary to have this opening, or the water would not have found its way into the boiler at all, as was proved by actual experiment with it closed, when the first puff of steam generated forbad the entry of more water, and drove back through the feed pipe. The opening, however, would not have had the slightest effect in preventing the bursting of the boiler, if the views entertained with regard to the explosive effect of dashing water on red hot plates were correct, the action of which is supposed to be as irresistible and instantaneous as that of gunpowder.

"The result of this experiment was so unmistakable that it appeared of itself to be conclusive, but still it was thought more satisfactory to repeat it with another boiler, of slightly different dimensions, by way of corroboration.

"The second boiler, which, like the first, was of copper, weighed 44 lbs., and measured $11\frac{3}{4}$ inches in height, $11\frac{1}{2}$ inches in width, by $10\frac{1}{2}$ inches in depth at the bottom, and $8\frac{1}{2}$ inches at the top, having a flue tube running through it 6 inches in diameter, so that it had an internal capacity of about $\frac{5}{8}$ths of a cubic foot. This boiler was surrounded, just as the previous one had been, by a brisk fire, which operated not only on the bottom and sides, but also on the internal flue tube, and it was allowed to remain perfectly empty as in the previous experiment, until lead, loosely laid on the top, freely melted, and nearly half of the boiler became red hot, when water was suddenly turned into it through a pipe of 1 inch bore, connected to the boiler at one end to a tank, affording a head of from 6 to 8 feet in height at the other. This plan of feeding was adopted in preference to that in the first experiment, thinking that the increased size of the pipe would give a more sudden injection of water, and thus prove more favourable to an instantaneous generation of steam. The result, however, was precisely the same as in the previous experiment; no explosion whatever occurred, the boiler remained perfectly still, and the only effect of the injection of the water was the escape of a jet of steam through an orifice 1 inch in diameter, which had been left open on the top of the boiler.

"This experiment, therefore, completely corroborated the previous one; but inasmuch as both of the boilers referred to above were made of copper, whereas many in use are made of cast iron, it was thought well to repeat the experiment with a cast-iron boiler, which it was expected would prove more favourable to explosion, not only on account of the brittleness of its material, but also from its greater weight of metal, which would afford increased capacity for heat, and thus for rapidly generating steam.

"The third boiler, which, as just stated, was of cast iron, weighed 85 lbs., and measured $15\frac{1}{4}$ inches in length, 10 inches in height, by $11\frac{1}{2}$ inches in depth at the bottom and $8\frac{1}{4}$ inches at the top, having an internal capacity of less than a cubic foot, while the bottom was arched, which increased the heating surface. This boiler, like the previous ones, was heated till the greater part of it became red hot, and lead melted on the top; indeed, it was in such a glowing heat, that it appeared, on looking into it through a small orifice, as if the bottom had been burnt out, and the eye was looking directly into the fire itself. Water was then laid on, as in the previous experiments, by means of a pipe 1 inch in diameter, connecting the boiler to a tank giving a head of from 6 to 8 feet, but there was no orifice left open on the top of the boiler as before, a safety-valve, loaded to a pressure of about 35 lbs. on the square inch, being substituted. On opening the tap in the connecting pipe, and letting the water on, no result whatever was apparent. The safety-valve did not blow, and the boiler neither cracked nor trembled, but the feed pipe was found to get hot up to the tap, some 15 feet from the boiler, as if the steam was beating back and forbidding further entry of the water. After allowing the boiler to rest in this position for some time, with the fire briskly burning around it, the safety-valve was lifted, when a very moderate escape of steam took place, and continued as long as the valve was kept open, but ceased as soon as it was allowed to fall. Finding that no result could be produced with the safety-valve attached to the boiler, it was removed, and an orifice of $1\frac{1}{4}$ inches in diameter left open instead. On turning the water on again, a jet of steam escaped from the orifice as before, and shortly after the boiler cracked on one side from the top to the bottom with a sharp report. This was due simply to the contraction of the metal, and the rupture did not spread, neither did the boiler stir from its seat. The water was kept on till the boiler was nearly filled, but no result followed different to those already described.

"To render the experiments as conclusive as possible, it was thought well to repeat the last one for corroboration, and therefore the boiler was removed from the fire, emptied, and replaced, the connections being completed just as before, with the exception that the safety-valve was omitted, and the orifice on the top reduced to a diameter of $\frac{3}{8}$ths of an inch. On turning on the water again, the only result was a jet of steam as before, which issued from the orifice on the top of the boiler in a constant stream as long as the feed tap was kept open, and intermittently when it was opened and closed alternately.

"It should be added that the capacity of these boilers was such that a pressure of about 150 lbs. on the square inch would have been generated within them by the evaporation of a quarter of a pint of water in the two larger ones, and an eighth of a pint in the smaller one, and though they were heated all over, as already described, yet it is clear that that pressure could never have been attained or even approached, as the light, flat-sided copper boilers did not bulge in the least, while the rush of steam from the outlet never appeared more than could be taken off by an ordinary safety-valve.

"It will be seen, from the results of the foregoing experiments, that all the attempts to explode the boilers totally failed. Every endeavour, however, was made to succeed, and everything that glowing red hot plates and cold water could do, under the circumstances described, was done; while it is thought that the test adopted was much more severe than any which could occur in actual work, either to a household boiler on the occurrence of frost, or to one employed for engine power on the furnaces being overheated, and the feed suddenly re-admitted to the red hot plates. In the case of the household boiler, the fire rarely operates further than upon the bottom and one or two of the sides, whereas the experimental ones were completely surrounded by fire, so that the amount of heated surface was greater in the experiment than it could be in practice; while the injection of the water through the supply pipe of an inch bore, simply by opening a tap, was, it is thought, at least as sudden as it possibly could be by the thawing of a column of ice; added to which it was shown by experiment that the water would not flow into the boiler without a free outlet as well as a free inlet, so that unless both of the circulating pipes were open at the same time, but little water would get into the boiler. In the case of the steam boiler for engine purposes, its capacity would be very much larger in comparison with the amount of heated surface exposed on the furnace crowns being laid bare than in the experimental ones, so that the force of the steam would be proportionally reduced, and so much so in practice as to be completely swallowed up.

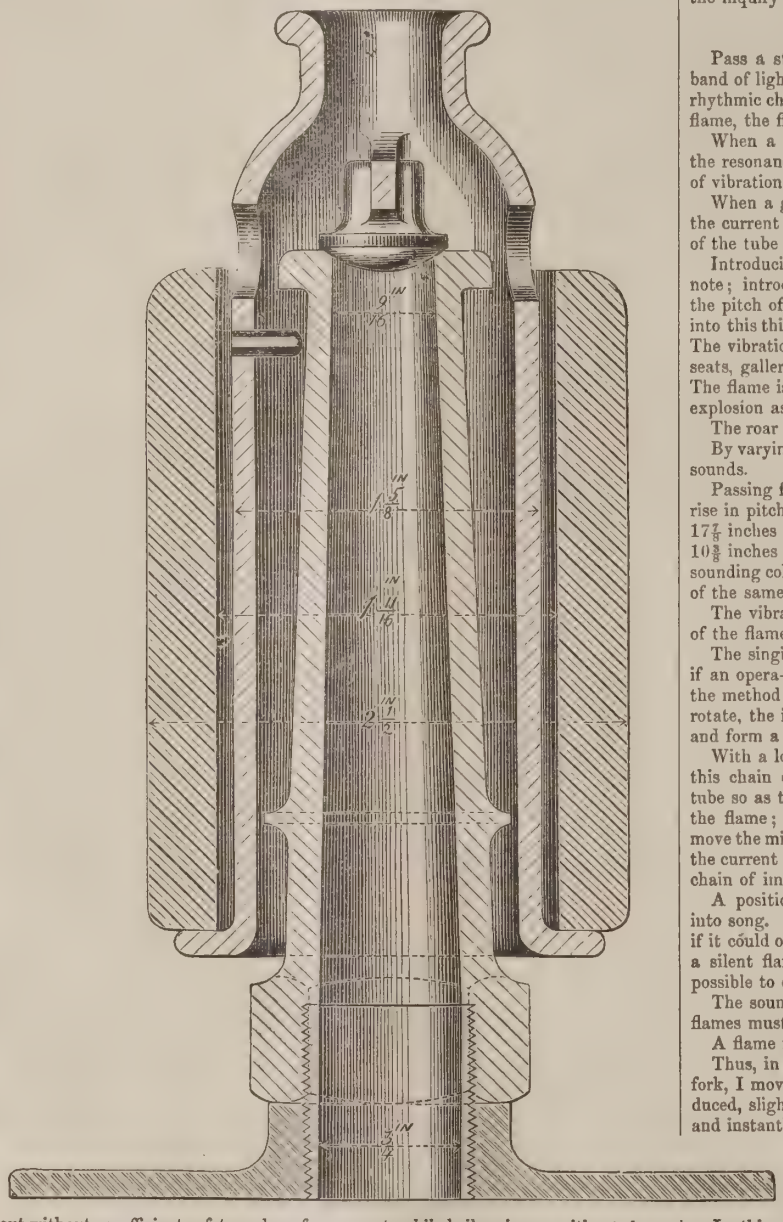
"The experiments were witnessed by others as well as myself, the desire of all being to make them as satisfactory and conclusive as possible, and though we failed in exploding the boilers, I trust something may have been done towards exploding the theory they were instituted to test, a theory which has done so much to perpetuate fatal steam boiler explosions by arresting full investigation, and throwing dust in the eyes of coroners and jurors, while inquiring into the cause of these sad catastrophes.

"These experiments may, it is thought, be accepted as conclusive, that the idea of explosions arising from the instantaneous generation of a large amount of steam through the injection of water on to hot plates is a fallacy; and that the bursting of circulating boilers during frost is due simply to accumulated steam pressure within them from the choking of the outlet pipes with ice, while that pressure may be relieved and explosion prevented by a good safety-valve, as previously recommended.

* "It may prove of convenience to the brass founder to state that for the above proportions, with a diameter of nine-sixteenths of an inch at the bore of the valve seating, the weight of the external brass shell should be 1 lb. 1 oz. as nearly as may be, and that of the lead weight $4\frac{1}{4}$ lbs. or 1 lb. 1 oz. for each inch of its height.

"There may doubtless be other safety-valves of equal merit with the above, but on account of its known efficiency under other circumstances, it is trusted that the preceding description will prove of service; but whether this particular construction be adopted or not, it is recommended that no new household boiler should be turned

Fig. 5.



out without an efficient safety-valve of some sort, while boilers in use without them, having supply pipes at all liable to be affected by frost, should have a valve added as shortly as possible."

ROYAL INSTITUTION OF GREAT BRITAIN.

UPON THE RELATIONS OF FLAME TO AERIAL VIBRATION.

THE subject of the lecture recently delivered by Dr. Tyndall at the Royal Institution is one having so much of interest and novelty, that we think our readers will be glad to have presented to them the following abstract, the rather as no account of the lecture has yet appeared in print that we are aware of, except in the pages of the *Journal of the Royal Institution*—which are scarcely accessible except to members.

ON SOUNDING AND SENSITIVE FLAMES.

HISTORICAL.

The sounding of a hydrogen flame when inclosed within a glass tube was, I believe, first noticed by Dr. Higgins, in 1777. The subject has been since investigated by Chladni, De la Rive, Faraday, Wheatstone, Rijke, Sondhauss, and Kundt. The action of unisant sounds on flames inclosed in tubes has been investigated by Count Schaffgotsch and myself. The jumping of a *naked* fish-tail flame in response to musical sounds was first noticed by Professor Lecomte at a musical party in the United States. He made the important observation that the flame did not jump until it was near *flaring*. That his discovery was not further followed up by this learned investigator was probably due to too great a stretch of courtesy on his part towards myself. Last year, while preparing the experiments for one of my "Juvenile Lectures," my late assistant, Mr. Barrett, observed the effect independently; and he afterwards succeeded in illustrating it by some very striking experiments. With a view to the present discourse, and also to the requirements of a forthcoming work on sound, the subject of sounding and sensitive flames has been recently submitted to examination in the laboratory of the Royal Institution. The principal results of the inquiry are embodied in the following abstract.

ABSTRACT OF LECTURE.

Pass a steadily-burning candle rapidly through the air, you obtain an indented band of light, while an almost musical sound heard at the same time announces the rhythmic character of the motion. If, on the other hand, you blow against a candle-flame, the fluttering noise produced indicates a rhythmic action.

When a fluttering of the air is produced at the embouchure of an organ-pipe, the resonance of the pipe reinforces that particular pulse of the flutter whose period of vibration coincides with its own, and raises it to a musical sound.

When a gas-flame is introduced into an open tube of suitable length and width, the current of air passing over the flame produces such a flutter, which the resonance of the tube exalts to a musical sound.

Introducing a gas-flame into this tin tube 3 feet long, we obtain a rich musical note; introducing it into a tube 6 feet long, we obtain a note an octave deeper—the pitch of the note depending on the length of the tube. Introducing the flame into this third tube, which is 15 feet long, the sound assumes extraordinary intensity. The vibrations which produce it are sufficiently powerful to shake the pillars, floor, seats, gallery, and the five or six hundred people who occupy the seats and gallery. The flame is sometimes extinguished by its own violence, and ends its peal by an explosion as loud as a pistol shot.

The roar of a flame in a chimney is of this character: it is a rude attempt at music.

By varying the size of the flame, these tubes may be caused to emit their harmonic sounds.

Passing from large pipes to small ones, we obtain a series of musical notes, which rise in pitch as the tube diminishes in length. This flame, surrounded by a tube $17\frac{7}{8}$ inches long, vibrates 459 times in a second, while that contained in this tube, $10\frac{3}{8}$ inches long, vibrates 717 times in a second. Owing to the intense heat of the sounding column, these numbers are greater than those corresponding to organ-pipes of the same lengths sounding in air.

The vibrations of the flame consist of a series of partial extinctions and revivals of the flame.

The singing flame appears continuous; but if the head be moved to and fro, or if an opera-glass, directed to the flame, be caused to move to and fro; or if, after the method of Wheatstone, the flame be regarded in a mirror which is caused to rotate, the images due to the revivals of the flame are separated from each other, and form a chain of flames of great beauty.

With a longer tube and larger flame, by means of a concave mirror, I can project this chain of flames upon a screen. I first clasp my hand round the end of the tube so as to prevent the current of air which causes the flutter from passing over the flame; the image of the flame is now steady upon the screen before you. I move the mirror, and you have this continuous luminous band: I withdraw my hand; the current of air passes over the flame, and instantly the band breaks up into a chain of images.

A position can be chosen in the tube at which the flame bursts spontaneously into song. A position may also be chosen where the flame is silent, but at which, if it could only be started, it would continue to sound. It is possible to start such a silent flame by a pitch-pipe, by the syren, or by the human voice. It is also possible to cause one flame to effect the musical ignition of another.

The sound which starts the flame must be nearly in unison with its own. Both flames must be so near unison as to produce distinct beats.

A flame may be employed to detect sonorous vibrations in air.

Thus, in front of this resonant case, which supports a large and powerful tuning-fork, I move this bright gas flame to and fro. A continuous band of light is produced, slightly indented through the friction of the air. The fork is now sounded, and instantly this band breaks up into a series of distinct images of the flame.

Approaching the same flame, towards either end of one of our tin tubes, with the sounding flame within it, and causing it to move to and fro, the sonorous vibrations also effect the breaking up of the band of light into a chain of images.

In this glass tube, 14 inches long, a flame is sounding: I bring the flat flame of a fish-tail burner over the tube, the broad side of the flame being at right angles to the axis of the tube. The fish-tail flame instantly emits a musical note of the same pitch as that of the singing flame, but of different quality. Its sound is, in fact, that of a membrane, the part of which it here plays.

Against a broad bat's-wing flame I allow a sheet of air, issuing from a thin slit, to impinge. A musical note is the consequence. The note can be produced by air or by carbonic acid; but it is produced with greater force and purity by oxygen. The pitch of the note depends on the distance of the slit from the flame.

Before you burns a bright candle flame: I may shout, clap my hands, sound this whistle, strike this anvil with a hammer, or explode a mixture of oxygen and hydrogen. Though sonorous waves pass in each case through the air, the candle is absolutely insensible to the sound; there is no motion of the flame.

I now urge from this small blow-pipe a narrow stream of air through the flame of the candle, producing thereby an incipient flutter, and reducing the brightness of the flame. I now sound the whistle; the flame jumps visibly. Matters may be so arranged that when the whistle sounds the flame shall be either almost restored to its pristine brightness, or that the amount of light it still possesses shall disappear.

Before you now burns a bright flame from a fish-tail burner. I may, as before, shout, clap my hands, sound a whistle, or strike an anvil; the flame remains steady and without response. I urge against the broad face of the flame a stream of air from the blow-pipe just employed. The flame is cut in two by the stream of air. It flutters slightly, and now when the whistle is sounded the flame instantly starts. A knock on the table causes the two half-flames to unite and form for an instant a flame of the ordinary shape. By a slight variation of the experiment, the two

side flames disappear when the whistle is sounded, and a central tongue of flame is thrust forth in their stead.

Passing from a fish-tail to a bat's-wing burner, I obtain this broad steady flame. It is quite insensible to the loudest sound which would be tolerable here. The flame is fed from this gas-holder, which places a power of pressure at my disposal unattainable from the gas-pipes of the Institution. I turn on more gas; the flame enlarges, but it is still insensible to sound. I enlarge it still more, and now a slight flutter of its edge answers to the sound of the whistle. Turning on a little more gas, and sounding again, the jumping of the flame is still more distinct. Finally I turn on gas until the flame is on the point of roaring, as flames do when the pressure is too great. I now sound my whistle; the flame roars and thrusts suddenly upwards eight long quivering tongues.

I strike this distant anvil with a hammer, the flame instantly responds by thrusting forth its tongues.

Another flame is now before you. It issues from a burner, formed of ordinary gas-tubing by my assistant. The flame is 18 inches long, and smokes copiously. I sound the whistle; the flame falls to a height of 9 inches, the smoke disappears, and the brilliancy of the flame is augmented.

Here are two other flames, also issuing from burners formed by my assistant. The one of them is long, straight, and smoky; the other is short, forked, and brilliant. I sound the whistle; the long flame becomes short, forked, and brilliant; the forked flame becomes long and smoky. As regards, therefore, their response to the sonorous waves, the one of these flames is the exact complement of the other.

Here are various flat flames, 10 inches high, and about 3 inches across at their widest part. They are purposely made forked flames. When the whistle sounds, the plane of each flame turns ninety degrees round, and continues in its new position as long as the whistle continues to sound.

Here again is a flame of admirable steadiness and brilliancy, issuing from a single circular orifice in a common iron nipple. I whistle, clap my hands, strike the anvil, and produce other sounds, the flame is perfectly steady. Observe the gradual change from this apathy to sensitiveness. The flame is now 4 inches high. I make its height 6 inches; it is still indifferent. I make it 10 inches, a barely perceptible quiver responds to the whistle. I make it 14 inches high, and now it jumps briskly the moment the anvil is tapped or the whistle sounded. I augment the pressure, the flame is now 16 inches long, and you observe a quivering which announces that the flame is near roaring. I increase the pressure; it now roars, and shortens at the same time to a height of 8 inches. I diminish the pressure a little; the flame is again 16 inches long, but it is on the point of roaring. It stands as it were on the brink of a precipice. *The whistle pushes it over.* Observe it shortens when the whistle sounds, exactly as it did when the pressure was in excess. The sonorous pulses, in fact, furnish the supplement of energy necessary to produce the roar and shorten the flame. This is the simple philosophy of all these sensitive flames.

The pitch of the note chosen to push the flame over the brink is not a matter of indifference. I have here a tuning-fork which vibrates 256 times in a second, emitting a clear and forcible note. It has no effect upon this flame. Here are three other forks, vibrating respectively 320, 384, and 512 times in a second. Not one of them produces the slightest impression upon the flame. But, besides their fundamental notes, these forks can be caused to sound a series of overnotes of very high pitch. I sound this series of notes: the vibrations are now 1600, 2000, 2400, and 3200 per second respectively. The flame jumps in response to each of these notes; the response to the highest note of the series being the most prompt and energetic of all.

To the tap of a hammer upon a board the flame responds; but to the tap of the same hammer upon an anvil the response is much more brisk and animated. The reason is, that the clang of the anvil is rich in the higher tones to which the flame is most sensitive.

Here again is an inverted bell, which I cause to sound by means of a fiddle-bow, producing a powerful tone. The flame is unmoved. I bring a halfpenny into contact with the surface of the bell: the consequent rattle contains the high notes to which the flame is sensitive. It instantly shortens, flutters, and roars when the coin touches the bell.

Here is another flame, 20 inches long. I take this fiddle in my hand, and pass a bow over the three strings which emit the deepest notes. There is no response on the part of the flame. I sound the highest string: the jet instantly squats down to a tumultuous bushy flame, 8 inches long. I have here a small bell, the hammer of which is caused to descend by clock-work. I hold it at a distance of 20 yards from the flame. The strokes follow each other in rhythmic succession, and at every stroke the flame falls from a height of 20 to a height of 8 inches.

The rapidity with which sound is propagated through air is well illustrated by these experiments. There is no sensible interval between the stroke of the bell and the shortening of the flame.

Some of these flames are of marvellous sensibility; one such is at present burning before you. It is nearly 20 inches long; but the slightest tap on a distant anvil knocks it down to 8. I shake this bunch of keys or these few copper coins in my hand: the flame responds to every tinkle. I may stand at a distance of 20 yards from this flame: the dropping of a sixpence from a height of a couple of inches into a hand already containing coin, knocks the flame down. I cannot walk across the floor without affecting the flame. The creaking of my boots sets it in violent commotion. The crumpling of a bit of paper, or the rustle of a silk dress, does the same. It is startled by the plashing of a raindrop. I speak to the flame, repeating a few lines of poetry; the flame jumps at intervals, apparently picking certain sounds from my utterance to which it can respond, while it is unaffected by others.

In our experiments downstairs we have called this the vowel flame, because the different vowel sounds affect it differently. Vowel sounds of the same pitch are known to be readily distinguishable. Their qualities or clang-tints are different, though they have a common fundamental tone. They differ from each other through the admixture of higher tones with the fundamental. It is the presence of these higher tones in different proportions that characterizes the vowel sounds, and it is to these same tones, and not to the fundamental one, that our flame is sensitive. I utter a loud and sonorous U, the flame remains steady; I change the sound to O, the flame quivers; I sound E, and now the flame is affected strongly. I utter the words *boot*, *boat*, and *beat* in succession. To the first there is no response; to the second, the flame starts; but by the third and fourth it is thrown into violent commotion; the sound *Ah!* is still more powerful. When the vowel sounds are analyzed their constituents are found to vary in accordance with the foregoing experiments; those characterized by the sharpest overtones being the most powerful excitants of the flame. (*See* Helmholtz in "Pogg. Annalen," vol. cviii., p. 286.)

The flame is peculiarly sensitive to the utterance of the letter S. If the most distant person in the room were to favour me with a "hiss," the flame would be instantly shivered into tumult. The utterance of the word "hush," or "puss," produces the same effect. This hissing sound contains the precise elements that most forcibly affect the flame. The gas issues from its burner with a hiss, and an external sound of this character added to that of a gas-jet already on the point of roaring is equivalent to an augmentation of pressure on the issuing stream of gas. I hold in my hand a metal box containing compressed air. I turn the cock for a moment so as to allow a puff to escape—the flame instantly ducks down, not by any transfer of air from the box to the flame, for I stand at a distance which utterly excludes this idea; it is the *sound* of the issuing air that affects the flame. The hiss produced in one orifice precipitates the tumult at the other.

MONTHLY NOTES.

MARINE MEMORANDUM.

Rapid Steaming.—On Thursday night, the 21st ult., the paddle-steamer *Buffalo*, Captain M'Pherson, left Greenock with a considerable party on board, and reached Londonderry Quay in eight and a half hours. The distance is about 135 miles. The average rate of speed was therefore about 16 knots, or nearly 19 miles an hour. This is said to be the fastest passage ever made. On the following Friday afternoon the *Buffalo* arrived at Greenock shortly before five o'clock, having made the passage from Londonderry Quay in ten hours forty-fifty minutes, against a gale of easterly wind, accompanied by thick snow. The paddle-steamer *Rose*, which also arrived on the same day from Londonderry, was several hours longer on the passage. The weather outside was reported as being very severe. The *Buffalo* belongs to Messrs. Burns, Glasgow. She was to be placed on the Londonderry station on the 30th ult.

The Channel Railway.—After considerable investigation on the part of Mr. Hawkshaw, it is now reported that he has so far satisfied himself of the nature of the bottom of the English Channel, as to have concluded that the faults and fissures therein are too deep to admit of tunnelling being practicable. Since it is tolerably well certain, as shown on another page, that Chalmers' proposal as well as any other submarine scheme is impracticable, or if practicable in construction, is, to say the least, impossible to render permanent, we are driven to devise a system of communication in which travelling mortals will not have to submit to what at all times would be a most distasteful realization, the fact of being hurled along at railroad speed into the very *ventra* of the earth or sea. If this report of Mr. Hawkshaw's exploration of the Channel bottom be true, it is not at all unlikely that the time is at no great distance when Mr. Fowler's proposal for a huge train ferry across the Straits of Dover will be carried out; it certainly promises the readiest and least expensive mode of providing that constancy of transit and re-transit between the two countries which has now become a necessity. Whatever proposals may be in the future for this desirable link of railway communication, we are among those, and we know that numerous members of the profession think with us, that a gigantic bridge is the thing after all—a far more tangible and practicable thing than a tunnel or submarine tubular way either; only it must be understood that we should propose a bridge of widely different construction, and at a considerably altered cost, than has been proposed by others of our professional cotemporaries. The chief difficulties in the way of such a bridge become much reduced when they are closely and particularly enough examined. It is not to be supposed that because one or two proposals for crossing great breadths of estuarine friths at home have for the time been given up, until the railway companies about constructing them shall have recovered their commercial stability, that therefore the works are among the class of ideas that cannot be; on the contrary, it appears that the channel affords special facilities for such a bridge, as, when the proper time arrives, there are those amongst us ready to propose.—V. D.

The Atmosphere.—The same atmosphere, unsullied by human neglect and sordid necessity, exists in its fullest purity for miles as we ascend, to a height greater than man has yet gone or can go. Colourless when near, its transparent depths are the medium of reflected colour, which, as we ascend beyond the influence of earthly vapours, deepens to an intensity of blue we know nothing of below. The air is a blending of subtle gases, of which more than 99 per cent. consists of oxygen and hydrogen, a great part of the remainder of aqueous vapour and carbonic acid, with other gases in very small proportions. These quantities prevail at all elevations, whether among mountains, or vertically in space, up to the greatest height which has yet been attained. With these aeriform fluids the waters of the earth mix in alterable proportions, according to the process of evaporation. Invisibly suspended, the aqueous vapour of the atmosphere varies in quantity according to the season of the year and the hour of the day; its regulating power is temperature, which, as the air becomes cooled, condenses vapour into visible form and substance. For miles above the earth a variable quantity of water is mixed with the air. It is this union of two dissimilar fluids which produces the whole visible phenomena of cloud, haze, fog, &c. Whenever the temperature of the air declines from any cause, the moisture, which at the higher temperature was in the invisible form of vapour, is condensed, and assumes the visible shape of clouds.—*Glaisher.*

New Means for Crossing the Mississippi.—It is reported that proposals have recently been made to cross the Mississippi by a tube laid on the river bed at St. Louis, U.S. This mode of effecting the passage is considered by those who have examined the matter to be in every way more expedient than a tunnel.

Utilization of Compressed Air for Mining Operations in Australia.—We learn that compressed air is now introduced in Australia for actuating the machinery there used for pumping and ventilating the mines. The air is compressed by a steam-engine outside the mine, and the compressed air is carried by a pipe to an engine within the mine, and there works pumps to lift out the water, while the air escaping from the engine both ventilates the mine and cools it.

The Production of Heat from the Rotation of Aluminium and Ebonite Discs in Vacuo.—It has been ascertained by Messrs. Stewart and Tait, who have been conducting a series of experiments upon the effects produced on discs of aluminium and ebonite rotated *in vacuo* at a high velocity, that the temperature of such discs becomes elevated. It is stated by a cotemporary that they find this heating is *not* at all caused by the communication of external heat from the bearings or elsewhere, nor from vibrations communicated to the discs themselves, nor from the operation of the magnetic force of the earth; and the question consequently arises in what way it can have been generated? At present we are very far from believing that heat may not yet be found to be developed from one of the causes alluded to; for it is not stated, at least so far as we have been able to gather, that the experimenters accept their results yet as *absolute proof*. In these days of rapid development of the physical sciences, it is almost impossible to say whether or not the particles of light may not yet be found to exert resistance to bodies in motion. That such may yet be found we have reason to expect; and after all, if proved, it will only then be the effect of the resistance caused by electric action, of which light is one of the forms; in a word, the effect of the influence of gravitation of which light, heat, electricity, &c. &c., so far appear to be some of its visible forms. Our cotemporary further remarks:—"It is not impossible that, by pursuing this investigation, some unknown form of force may be discovered, or, perhaps, some new manifestation of the odylic force of Reichenbach may be detected. When we remember how short the time is since we became acquainted even with such a familiar force as galvanism, we may fairly expect that we shall find out many other forms of force now unknown; just as we have discovered many new metals in the present century, of which no knowledge existed in the last." We may, perhaps, with propriety, suggest to the experimenters that, to improve the general knowledge on the probable effects of light to which we have alluded, they should conduct some observations in light of various degrees of accurately ascertained intensity, as well as others in absolute darkness; noting the results and differences of temperature, if any, in every particular case, for equivalent quantities of rotation imparted to the discs.—V. D.

Liquid Fuel.—It is stated by the *American Artizan* that Captain Schpakovski has constructed a peculiar lamp, which may be regarded as the typical instrument of his system. The flame of this lamp, fed by turpentine, rises to the extraordinary height of two feet, and it issues from the burner with a noise that resembles that caused by the rush of steam out of a pipe; its colour is yellowish-white, and its temperature is that of the fusing point of steel. The quantity of turpentine consumed by the lamp in connection with the pulverizer is from two to five pounds per hour. Captain Schpakovski commenced his public experiments with the fusion of fine steel wire, which, after a few seconds, began to melt and burn away in sparks. He then gave the flame a horizontal direction, and melted a piece of copper. He also exhibited a crucible, intended with the aid of the pulverizer to melt pieces of copper weighing from five to ten pounds. The application to which Captain Schpakovski attaches the greatest importance, however, is the heating of the boilers of steamboats. He has constructed a small vessel, 24 feet long and 5 feet wide, with an engine of two horse-power, which performs 6½ knots an hour. The boiler is heated by four pulverizers, the turpentine being stored forward, and conducted through a tube, furnished with a regulator, to the pulverizers. The consumption of the liquid is stated to be equal to three pounds per hour per horse-power. The captain is now engaged in the construction of a vessel of three times the above power, and he expects, in consequence of improvements in the boiler, to be able to reduce the consumption to about half the above amount. It is said that orders for twenty steamers for St. Petersburg and the neighbouring places have already been received, and that it is proposed to establish communication, by means of small vessels on Captain Schpakovski's principle, on the Neva, between the town and the islands, so that passengers may be conveyed through the canals of the Moika and of Tontaka to the central station on the Neva, where the large vessels lie that run between that place and the islands. It is not pretended that the heating by means of turpentine will cost less per hour than coals, but as the former will not require the fires to be lighted more than ten minutes before starting, there will be a great economy in the case of very short runs like those on the Neva, which only occupy about half an hour. The new method is also applied to night signals, the lantern giving three times as much light as those at present in use.

Actual and Nominal Horse-power.—The actual or indicated horse-power of the screw engines of our navy is usually from four to five times the nominal, but the introduction of various improvements widens the disparity daily. The engines of the *Bellerophon* worked up to more than six times the nominal power, and the result was very properly regarded as an admirable proof of the excellence of Messrs. Penn's machinery. But a result has recently been obtained by Messrs. Maudslays and Field which throw all previous performances of this kind into the shade. On her trial trip the engines of H.M.S. *Vestal*, 300 horse-power nominal, worked up to 2138 horse-power indicated, or, as nearly as may be, seven and a quarter times the nominal power. This is by far the largest proportion of actual to nominal power ever obtained with any of the new class of engines fitted in Admiralty ships, and the fact speaks strongly in favour of Messrs. Maudslays and Field's three-cylinder engines.—*Engineer*.

New Telegraph Instrument.—There is now on trial at the chief office of the London District Telegraph Company, in Cannon-street, a telegraph instrument which, in point of detail and result, appears to be the nearest approach to simplicity and perfection hitherto available for public or private use. It is a printing instrument, producing letters printed in ordinary type by means of pressing small keys bearing the respective letters. It is worked, says the *Star*, by a combination of clockwork and electricity, and has now been in use for some weeks without derangement. Other somewhat similar results have been arrived at by other instruments, but with the exception of that invented by Professor Hughes, none have been brought into successful use. This instrument has, however, many advantages over that of Professor Hughes. It does not exceed 15 square inches in size. It is extremely simple in all its arrangements, is portable, and costs less than a third of that invented by Professor Hughes. These many advantages render it particularly suitable for private telegraphs, as any one can work it. A printed record is kept of the message, and should no person be in attendance to receive a message when transmitted, the printed slip will remain for attention as soon as any one is present to attend to it. Should the proposed annexation of the telegraph to the General Post Office be carried out, this will be a most useful instrument for use at all the minor post office and telegraph stations.—*Mechanic's Magazine*.

Extraordinary Discoveries at Rome.—Pursuing our way under the shadow of the Claudian arcades, we come upon a sluice of the Julian aqueduct, similar in method to the locks of our modern canals, but as the channel is here narrow, of diminutive scale; and it may be concluded that the great villa of Commodus, whose ruins still stand imposingly near the Appian Way, had its water supply from this branch of the same aqueduct. On the same level ground we may be startled by suddenly seeing a wide round orifice yawning at our feet, fenced by railings, through which we look down into a mysterious and dark abyss, known to be the piscina of the Marcian aqueduct; and Mr. Parker assured his auditors, on reliable authority, that we here stood above a stupendous subterranean dome, equal in diameter to that of St. Peter's, and with a vault of concrete 20 feet in thickness overhanging the vast reservoir that extends far in invisible depth below. The engineer of the Roman government, Signor Morandi, had lately the courage to descend and explore this extraordinary excavation. At a short distance, on a line with that orifice, rises a steep isolated mound, that might seem of natural formation, but is ascertained to be the centre shell of a similar, and not less enormous, dome, pertaining to a piscina of the Claudian aqueduct.—*Builder*.

Australian Diamonds.—Another diamond has been found in Australia, in the district of Beechworth. It was discovered in a *claim* at Sebastopol Creek, at a depth of 250 feet, amidst small blue and white topazes, hyacinths, zircons, tourmaline, and tin sand. Its weight in the diamond scales exceeded a carat and one-eighth.

Mid-Level Syphons.—The syphons erected by the Middle Drainage Commissioners near Lyme continue to work well. Thirty-three of the claimants for damages caused by the failure of the outfall sluice have accepted the offers made by the Board. The sums claimed amounted to 5518*l*., and the sums accepted to 4614*l*.

A New Discovery.—"A discovery has just been brought under our notice," says the *Majorca Independent* (an Australian paper), "which may eventually be productive of important results. A man named Bright was travelling overland from Adelaide to Majorca when, leaving the usual route (to look after some sheep), he came across numerous springs of what at sight appeared to be water, but on closer inspection proved to be a kind of liquid gum or oil, which on exposure to the air becomes solidified, at first to the consistency of jelly, and afterward to that of india-rubber—in which form we have now a piece in our possession. The peculiarity of this gum, or whatever it may be termed, is that it burns freely, with a bright flame, but accompanied with a thick smoke, and a smell as of old grease, such as would be emitted from machinery oil while in a state of combustion. The substance is light, and floats easily in water. Our informant assures us that a tract of country not less than 10 miles square is covered at intervals with the bubbling springs, while between them the solidified gum is lying in such abundance that many shiploads might be gathered with very little trouble. The exact *locale* of the discovery is preserved as a secret, but is stated to be within 60 miles of the coast. A small block of this curious substance has been forwarded to Melbourne for analysis." It does not appear at all improbable that this substance will be found to be one of the many kinds of petroleum. We saw some time since a substance brought from the Greek island Zante, which appeared to us very similar to what is above stated.

Floating Steam Fire Engine for Calcutta.—On Wednesday the 20th inst., some experiments took place in the river above Blackfriars bridge with a floating steam fire engine, constructed by Messrs. Shand, Mason, & Co., of London, to the order of the Indian government, for Calcutta. The propelling power and general arrangement of the fire engine pumps are to the designs of the government engineers at Calcutta, and suited for local use and for the swift current of the Hooghly. The principal dimensions are as follows:—Length of iron boat (built by Messrs. Richardson, Duck, & Co.), 130 feet; breadth of beam, 16 feet; depth of hold, 7 feet 5 inches; propelled by a screw 4 feet 6 inches in diameter. The steam engines, which are non-condensing, are placed horizontally across the boat, working the screw shaft direct at 200 revolutions per minute. There are two 12-inch cylinders, making a 15-inch stroke, with a boiler pressure of from 80 to 100 lbs. on the square inch. The fire engines consist of three pairs of bucket and plunger pumps, worked from a three-throw crank, the cylinders in each pair being at right angles to each other, and worked from the same throw of crank. The pump buckets are bare 10 inches in diameter, making a 12-inch stroke. The water is drawn from a perforated well in the side of the boat, each pair of pumps being fitted with a stop valve to allow of any pair being disconnected, so that one, two, or three pairs may be used at one time. There are also arrangements for attaching flexible suction pipes to pump from the holds of ships. The boilers are four in number, with horizontal brass tubes, these being sufficient to work the engines to their full power. The engines are connected on one side by a clutch with the screw shaft, and on the other side by a similar clutch with a shaft geared to the crank by a mortice wheel and pinion. The floating engine was on Wednesday, at 12 o'clock, drawn up alongside the wharf opposite Messrs. Shand, Mason, & Co.'s premises in Upper Ground Street, and shortly afterwards proceeded up the river, having on board several gentlemen who are interested in fire engines. The distance between Westminster and Vauxhall bridges being exactly a mile, taking the bend of the river into account, this was considered a suitable place for trying the speed of the boat. The first mile up was made in three minutes fifty-one seconds, and the second mile down in five minutes twenty seconds, making an average speed of between 13 and 14 miles an hour. On returning, the boat was moored alongside the India Stores Department, in the Belvedere Road, when Major-general Willoughby, the principal store-keeper, came on board to inspect the working of the fire engines. The hose outlets are six in number, each provided with Captain Shaw's

stop valves: to these six lines of hose were attached, with a jet of 1½ inch diameter at the end of each. With the engines in full power, the water pressure reached over 100 lbs. on the square inch, indicating that a vertical height of upwards of 150 feet was reached by the water. Several diagrams were taken by Richard's indicator, the highest of which gave 290 horse-power. This is the second self-propelling floating steam fire engine constructed in London. The first was made by Shand and Mason for the London Fire Brigade in 1855, and now in use for the protection of waterside property. The boat is made in segments, and will be immediately taken to pieces for shipment to India.

Railways in and to India.—There is no man who, from first to last, has done more good work for the promotion of railway communication in India than Mr. W. P. Andrew. From the time when, more than twenty years ago, he wrote a remarkable pamphlet, far in advance of the times, under the modest *nom de guerre* of an "Old Indian Postmaster," up to the present day, he has laboured most assiduously, and has devoted no common energy and ability to the furtherance of this great object. On the general subject of Indian railways, or any particular points connected with it, no man is listened to with more respect. We were glad, therefore, to see him the other day coming frankly and honestly forward to vindicate in the columns of the *Times* the Indian government with respect to the good faith which it had always observed in the matter of its guarantees. "I have been a party to no less than four contracts with the secretary of state for India in council conferring the advantages of the guarantee of the government of India on the several undertakings with which I am connected, and in no instance has there been for a moment the slightest cavil as to the amount of interest due from government, or a day's delay in the payment of the amount. Even during the height of the mutiny, the good faith and punctuality for which the government of India has ever been distinguished were as manifest as in ordinary times." This is no more than ought to be said about the good faith of the Indian government, but it is well that it should be said on such high authority. After this, Mr. Andrew goes on to explain in a very lucid manner the real character of government guarantees in India, and the precise powers which they confer on the government granting them. On this the *Times* observes, that "the evil incidental to Indian guarantees lies in the readiness of the Indian government to grant them. The moment any of the five per cent. enterprises creep up above par, a fresh supply is threatened, and thus the previous investors never see their stocks attain a proper position in the market. But for this constant swamping of any premium to which they may reach, they would probably before this have acquired a popularity in India that might have tempted native capital to flow into them, a result which has thus far been remarkably absent." Certainly, if the debt is, as Mr. Andrew suggests, to be looked upon as almost equally sacred with the liability to the English fundholder, it would be well that Parliament should at once assume a greater supervision over it, since in that case, while there is the present jealousy of affording the slightest aid to English lines, we may assume there would also be some disposition to restrain the extension of our credit commitments for a territory so distant. But the fact is that there is not at present any readiness on the part of the Indian government to guarantee any experiments of the kind, and that as far as we understand the matter, Parliament has really nothing to do with it. If an imperial guarantee were given, of course parliamentary supervision would be called for; but as it is, the supervision of the secretary of state for India in council, which is vigilantly exercised, is all that is required. Turning to another and perhaps more important subject, we may say that we observe with much satisfaction that Mr. Andrew is again moving—and he is one of those men who seldom move in such cases without eventual success—for the promotion of the great national scheme of the Euphrates Valley Railway. This is a project the immense advantages of which far transcend either the difficulty or the cost of execution. To open out a new and more expeditious "overland" route to India would seem to be a gigantic undertaking; but the impediments offered to it are small, and the facilities, on the other hand, such as to encourage every reasonable expectation of success in all the different aspects in which it can be regarded—political, military, commercial, and financial. On the present occasion, we merely glance at this important subject. But it is one which we shall keep steadily before us; and to which we shall return from time to time, as the scheme appears to develop itself. It cannot be in better hands. Napoleon said that he had faith only in successful men. Mr. Andrew has been eminently successful. The schemes which he has worked out have prospered; and this, the greatest scheme of all to which he has directed his energies, will, we believe, be eventually accomplished.—*Homeward Mail.*

Uniformity of Weights and Measurements.—The French, so long notorious for their endeavours to render universal their metrical system of measurement, which assumes for its radix $\frac{1}{10000000}$ of a quadrant of the earth's surface, have taken advantage of the occasion of the Exhibition in Paris this year to assemble an international conference for the discussion of these subjects. We are informed that several countries, *viz.*, Belgium, Holland, North and South Germany, Austria, Russia, Italy, and the United States have accepted the invitation of the French government.

Bursting of the Wakefield and Barnsley Canal.—At an early hour on Saturday morning, the 23rd ult., the Wakefield and Barnsley Canal, near the latter town, burst its banks, and the water has been run off for a considerable distance. Several collieries are consequently set down, and a large number of men thrown out of employment. The canal has burst at the aqueduct, and the water has flowed on to the low lands beneath.

Electrical Machines.—Electricians who are interested by the two machines recently made public by Professor Wheatstone and Mr. Siemens, referred to in another part of this issue, will be glad to learn that Mr. Clerk Maxwell has devised a way for ascertaining the amount of work really performed by such machines, and has embodied his method in a short paper, entitled "On the Theory of the Maintenance of Electric Currents by Mechanical Work without the aid of Permanent Magnets," which he has communicated to the Royal Society.

The Manure of Cities.—The city of Bordeaux is in a difficulty about its refuse; contractors complain of the trouble they find in getting rid of some 40,000 tons a year. The authorities, after having received considerable sums of money for the manure of the town, are at present obliged to pay about £20 a day to get rid of the mere refuse and sweepings of the streets, not including road sweepings and sewage. It seems scarcely credible, but is positively asserted, that the refuse of Bordeaux is used by the cultivators of Isle and Dordogne, at a distance of 50 or 60 miles from Bordeaux, while in the neighbourhood of the last-named place not a ton is employed. The last contractor, thinking that the proprietors of the lands would be glad to take advantage of the facilities offered by the Bayonne Railway and the rival roads for procuring manure, hired the ground belonging to the station of the Southern Railway, and there collected a mountain of refuse; nobody would have it, and it is gradually rotting away where it stands. It would naturally be supposed that the manure was not worth having, but the contrary is proved by long experience; the very same refuse is advantageously used in the neighbourhood of Perigord, although the purchasers have to pay the expense of river conveyance, which occupies fifteen days, and some other expenses. Scientific and practical men are now making great efforts to waken the agriculturists of the neighbourhood of Bordeaux to the fact that they are allowing this source of prosperity to lie unheeded at their doors.—*Jour. Soc. Arts.*

Béton Aggloméré.—The *béton aggloméré* of M. Coignet is a mixture of sand and hydraulic lime, thoroughly commingled by machinery, and when in this plastic state it is moulded into any desired form. It has been extensively employed in and about Paris for several years past, and it is stated that one of the station-houses on the St. Germains line of railway is entirely formed of it, the whole building being a monolith. About 20 miles of the sewers in Paris have been made of it, and it is largely employed for building works and ornaments.

The Strike of Railway Engine Drivers.—The following important notice was issued on the 25th ult. by the London, Brighton, and South Coast Railway:—"The public are respectfully informed that, in consequence of the strike of a large number of the engine-drivers and firemen, the time tables must be considered in abeyance. The utmost possible endeavour will be made to carry passengers to their respective destinations, but a large number of the trains must be taken off, and the speed of those run materially diminished."

Paris Exhibition.—The earthworks of the Paris Exhibition, including the Park, amount to upwards of half-a-million cubic yards. The ironwork amounts to 13,200 tons, of which 10,000 tons are in the great machinery gallery. The windows of this gallery present a surface of 53,700 square yards, and those of the other galleries 25,000. The structure itself occupies an area of 140,184 square yards. Of this, 61,000 square yards will be occupied by France, 21,653 by England, and 2900 by the United States.

Is it True?—The *American Artizan* says that a plan has been invented in England for colouring trees while they are growing.

John Bethell.—This gentleman, who was the patentee of the creosoting process for preserving timber, died in London, in the early part of last month, at the age of sixty-four. He was the only brother of Lord Westbury. *Engineering* states that Mr. Bethell took his idea of preserving wood by creosote from the embalming of mummies, the creosote having the property of coagulating albumen. Coal tar contains a considerable quantity of creosote, and when boiled to expel its ammonia it is called coal oil. The proportion of creosote in this oil is ascertained by mixing it with 10 per cent. of its own bulk of a strong caustic alkaline solution. After shaking and settling, three layers will be formed—the lower layer of caustic alkali, the next, forming from 8 to 18 per cent. of the whole, being creosote, while the bituminous oils float at the top. Mr. Bethell joined the Institution of Civil Engineers as an Associate, March 20th, 1838, but did not become a member. His creosoting patent was dated July 11th, 1838. He took out several patents, including ploughing engines, steatite bearings for carriages, and improvements in agriculture. He was at the time of his death chairman of the British and Foreign Railway Plant Company. He was elected a member of the Society of Arts in 1853, and not unfrequently spoke at its meetings.

Shipbuilding at Aberdeen.—To take a look round the half-dozen yards of the famous Aberdeen shipbuilders, there appears to be no sign of any slackness, in the north at least, in this important branch of industry. Vessels in various stages of progress are to be found in every establishment, while two splendid craft of the rather famous Aberdeen clipper build were launched at the same hour a week or two since. The larger of these two fine vessels is quite a model in outline and equipment aloft, while aboard ship she is fitted up in the most handsome style. Her dimensions are—length of keel, 212 feet; breadth, 35 feet, 2 inches; measurement, 1159 tons, N.N.M.; 1266, O.M.; 1306, O.N.M. The *Alexander Duthie*—so the vessel was christened by the wife of the builder, Mr. William Duthie, jun.—is classed A 1 at Lloyd's for nine years, and is to be engaged in the Australian and New Zealand trade. She has been completed under the personal inspection of her commander, Captain Douglass, late of the ship *Bayard*, of Liverpool. The other vessel, launched simultaneously, is nearly of the same size as indicated by the figures quoted above. She was built by the well-known firm of Messrs. John Duthie, Sons, & Co., and is in every respect worthy of the reputation of this eminent company. She was named the *Agnes Rose*, and is to trade to Australia under the command of Captain Purves, formerly of the ship *Silistria*. Both vessels are the property of local owners, and constitute a handsome addition to the tonnage of the port.

Mineral Specimens at the Paris Exhibition.—Dr. Dupuytren, one of the committee appointed to collect materials to represent California's resources at the Great Exhibition at Paris, in 1867, has collected several specimens of the various ores and metals found on this coast, many of which are of great beauty and value, and will doubtless attract much attention at the exhibition. Among the rarest specimens in the collection are some which contain metallic gold, silver, copper, and mercury, in combinations. There are few minerals known to the arts or sciences that will not be represented in the collection from California. Mr. Eaton, of San Francisco, has arranged to send ten arobas of exceedingly rich gold and silver ores from the Santa Quiteria mines at Valisco, Mexico. Several other parties are preparing to send important collections from other sections of the coast. As the whole will be under the care of Professor Blake, who has been actively engaged in examining the mineral resources of this coast for the past ten years, there is no doubt but these resources will be fairly represented.

APPLICATIONS FOR

PROVISIONAL PROTECTION FOR INVENTIONS

UNDER THE PATENT LAW AMENDMENT ACT.

☞ When the city or town is not mentioned, London is to be understood.

31st January, 1867.

261 C. W. Siemens, Westminster—Developing electric currents
262 G. A. J. Schott and J. S. Rosenthal, Bradford—Yarn
263 E. J. Padbury, Birmingham—Pipes for smoking
264 C E. Brooman, Fleet Street—Preparing silk.—A com.
265 E. H. Hughes, Clerkenwell—Colouring embossed glass
266 Henry Roberts, Cinderford—Ships' pumps
267 J. H. Johnson, Lincoln's Inn Fields—Traction engines.—A com.
268 John Lockwood and Henry Shaw, Leeds—Furnaces
269 E. T. Hughes, Chancery Lane—Cutting screws.—A com.
270 Archibald Craig, Mincing Lane—Fire grates
271 D. A. Halket, Newcastle-on-Tyne—Forging nails
272 Thomas Summerson, Darlington—Railway crossings
273 Thomas Bullivant, Ledbury Road—Window sashes

1st February, 1867.

274 T. Cooke and C. F. Cooke, York—Raising water
275 J. A. Murray, Manchester—Chimney tops
276 W. Fisken and D. Fisken, Stamfordham—Steam boilers
277 George Russell, Glasgow—Steam cranes
278 Isham Baggs, High Holborn—Obtaining motive power
279 O. M. Laverpilière, Paris—Fecundating agent
280 S. H. Foster, Leicester—Brace fabric
281 Eliza Walton, Islington—Mattresses
282 Frederick Ashford, Bermondsey—Securing bullion boxes
283 Henry Ermen, Pendlebury—Doubling cotton
284 Jacob Bührer, Munich, and A. P. Price, Lincoln's Inn Fields—Distillation of coal, &c.
285 W. E. Newton, Chancery Lane—Obtaining metals from ores.—A com.
286 N. T. Folsom, Laconia, U. S.—Artificial teeth
287 Frederick Bauman, King William Street—Machinery for making pulp

2nd February, 1867.

288 John Darling, Stane—Reservoir penholders
289 John Poole, Chelsea—Forming shafts, rollers, drums, &c.
290 J. G. Robinson, Elland—Kilns
291 Aaron Bradshaw, Accrington—Cock or tap
292 A. V. Newton, Chancery Lane—Steam generator.—A com.
293 J. Smith, Bradford, and G. Wilson, Huddersfield—Combing wool
294 William Richardson, Darlington—Horticultural buildings
295 H. B. Wright, Shelton—Supplying steam boilers with water
296 E. S. Crease, Plymouth—Engines for boring rock
297 John Stubbs, Winsford—Furnaces
298 J. G. Tongue, Chancery Lane—Self-oiling spindles.—A com.
299 R. D. Napier, Limehouse—Breaks
300 D. Greig, R. Burton, and F. Parker, Leeds—Engines for tilling land
301 Charles Vero, Atherstone—Hats
302 C. P. S. Wardwell, Gilford—Knitting machine
303 Benjamin Harlow, Macclesfield—Steam generator

4th February, 1867.

304 W. J. Baker, Fleet Street—Signalling in railway trains
305 G. W. Betjemann, Pentonville Road—Envelope cases
306 Maurice Cockerell, Hammersmith—Locks
307 J. F. Philippi, Paris—Pianofortes
308 Sir John Benson, Cork—Armour plates for ships
309 Samuel Plant and William Tatton, Sutton—Fire lighters
310 W. Dewhirst, J. Dewhirst, and T. Dewhirst, Bradford—Hoists
311 J. D. Bulloch, Liverpool—Self-fastening buckle.—A com.
312 James Earl of Caithness, Hill Street—Floating lights or beacons
313 C. V. Dusen, London—Printing names on newspapers.—A com.
314 J. J. Harrison, Manchester—Looms for weaving
315 Immanuel Liebich, Brighton—Musical Instruments
316 G. Haseltine, Southampton Buildings—Weavers' harness.—A com.

5th February, 1867.

317 P. M. Parsons, Blackheath—Permanent way of railways
318 S. L. Lucena, Enfield—Horse shoes
319 John Plews, Bucklersbury—Fire-arms
320 Thomas Craven, Leeds—Spinning frames
321 J. H. Johnson, Lincoln's Inn Fields—Metallic cases.—A com.
322 Joseph Ballouhey, Passavant—Vitrifying iron
323 A. V. Newton, Chancery Lane—Tinfoil.—A com.
324 J. G. Tongue, Chancery Lane—Drying yarn.—A com.

6th February, 1867.

325 J. Wright and T. Cobley, Copthall Court—Treatment of ores
326 John Box, Arundel Gardens—Fire-arms.—A com
327 W. E. Gedge, Strand—Paint.—A com.
328 David Barr and John Bloxham, Birmingham—Window fastenings
329 John Foxley, Stony Stratford—Bricks
330 G. A. Waller, Dublin—Filtering beer
331 C. E. Brooman, Fleet Street—Applying artificial pearls.—A com.
332 Thomas Rigby, Bradmore—Gun and pistol locks
333 Henry Dean and G. A. Wheeler, Wood End—Candlesticks
334 Stephen Alley, Glasgow—Machine tools
335 William Rigg, Cannon Street—Securing oil in cans
336 W. E. Newton, Chancery Lane—Bobbins.—A com.
337 James Graham, Warrington—Spelter from zinc ashes
338 A. B. Brown, Wandsworth Road—Drilling machines
339 William Prangley, Salisbury—Apparatus used in athletic exercises
340 Frederick Rosenauer, London—Stiffening yarns.—A com.
341 J. S. Hoar, Massachusetts—Bench vices

7th February, 1867.

342 John Ramsbottom, Crewe—Forging metal
343 W. G. Beattie, Surbiton—Slide valves
344 G. E. Pain, Camden Town, and Charles Corroy, Soho—Illuminating oils
345 Samuel Howard, Luton—Shaping hats
346 R. E. Green and William Laycock, Church—Printing textile fabrics
347 W. T. Carrington, Perth—Steam roller.
348 Enoch Siddaway, West Bromwich—Smoothing irons
349 H. K. York, Cardiff—Hot water heating apparatus
350 F. C. Leader, Haymarket—Venetian blinds
351 William Clark, Chancery Lane—Attaching teeth to saws.—A com.
352 William Clark, Chancery Lane—Automaton toys.—A com.
353 William Conisbee, Waterloo Road—Securing type
354 H. E. Falk, Liverpool—Furnaces

8th February, 1867.

355 William Kilbee, Smallheath—Fire-arms
356 Edwin Firth, Dewsbury—Ladies' mantles
357 M. J. Haines, Bath—Leather straps
358 W. S. Losh, Wreay Syke—Salt of ammonia
359 Arthur Ormsby, Westminster—Collecting rain-water
360 Thomas Sibley, Ashton-under-Lyne—Machines for washing
361 H. A. Fletcher, Whitehaven—Boring metals
362 J. H. Johnson, Lincoln's Inn Fields—Propellers.—A com.
363 D. N. Defries, Euston Road—Gas-burners
364 P. E. Gaiffe and A. A. Lalance, Paris—Electro-engraving
365 William Jones, Wolverhampton—Forging metals
366 Thomas Gill, Summer Bridge—Twisting yarns

9th February, 1867.

367 John Stanton, Wolverhampton—Gun lock
368 Richard Haworth and J. W. Welch, Manchester—Sizing yarn
369 George Daws, Penge—Railway signals
370 T. R. Jones, Liverpool—Bench and desk
371 John Brigham and Richard Bickerton, Berwick-on-Tweed—Reaping machines
372 E. A. Kirby, Gordon Square—Portable miniature dispensary
373 Edwin Heywood and Edward Hinchcliffe, Manchester—Fancy weavings
374 Friedrich Leonardt, Birmingham—Pen boxes
375 Jacob Bührer, Keppel Street—Generating steam
376 Robert James, Poole—Steam boilers
377 C. W. Dixon, Wickham Market—Mounting wheels on axles
378 Edouard Gorges, Neuilly—Preserving meat
379 William Clark, Chancery Lane—Preserving animal matters.—A com.
380 A. G. Grant, Regent's Park—Exhibiting pictures

11th February, 1867.

381 R. B. Mulliner, Liverpool—Shoes for horses
382 P. D. Collins, St. James—Bottle stopper
383 G. H. Kidd, Dublin—Regulating the supply of water
384 R. T. Thompson, Berwick Street—Studs and buttons
385 W. E. Newton, Chancery Lane—Treating vegetable substances—A com.

12th February, 1867.

386 John Ramsbottom, Crewe—Transferring engines, carriages, and waggons, from one line of rails to another
387 Edward Manico, Strand—Raising sand
388 William Stratford, Lincoln Street—Carriages
389 E. H. Bernier, Paris—Raising heavy bodies
390 J. B. Booth, Preston—Carding engines—A com.
391 Sir J. Y. Simpson, Bart., Edinburgh—Utilizing oils
392 J. H. Johnson, Lincoln's Inn Fields—Fire-arms.—A com.
393 William Clark, Chancery Lane—Motive power.—A com.
394 W. H. Towers, New York, U. S.—Preparing hides
395 Lieutenant Francis Bacon, Wymondham Rectory—Fire-arms
396 A. V. Newton, Chancery Lane—Sewing machines.—A com.
397 H. H. Grierson, Manchester, and John M'Elroy, Sale—Steam governors
398 William Clissold, Stroud—Tentering machine

13th February, 1867.

399 A. J. Paterson, Edinburgh—Fire-arms
400 Joseph Westwood, Bow, and Robert Baillie, Leyton—Iron safes
401 Joseph Westwood, Bow, and Robert Baillie, Leyton—Iron piles
402 W. E. Gedge, Strand—Steam boilers.—A com.
403 William Clark, Chancery Lane—Moulding bricks.—A com.
404 Henry Houfe, Upper Holloway—Lanterns
405 S. D. Mack, New York—Cleaning wheat
406 William Jones, Liverpool Street—Lamps
407 W. E. Newton, Chancery Lane—Portraits.—A com.
408 Samuel Osborne, Castle Street—Stays
409 H. A. Davis and S. J. Salkeld, London—Drawing liquids from casks

14th February, 1867.

410 John Thompson, Ardwick—Cutting metals
411 J. Walton, Wilmslow, and R. Harlow, Heaton Norris—Tilting barrels
412 H. A. Dufrené, Paris—Holder for tickets.—A com.
413 H. A. Dufrené, Paris—Railway tickets.—A com.
414 J. V. Toepken, Liverpool—Packing friction matches
415 George Ireland, Handsworth—Cruet frames
416 David Tenniswood, York—Boot toe-pieces
417 G. W. Wright, Bishopgate Street, Without—Street gutters
418 Thomas Greenwood, Leeds, and John Keats, Leek—Boots

15th February, 1867.

419 Richard George, Kilburn—Cinder shovels
420 J. P. Kerr and William M'Gee, Paisley—Chain beaming apparatus
421 W. J. Knowles and J. E. Wilding, Blackburn—Rollers
422 Robert Shaw, Preston—Motive power engines
423 Jasper Capper, Waterloo—Chimney top or cap
424 Pierre Duchamp, Lyons—Drawing of liquids
425 James Lamble, Southampton—Coating ships' bottoms
426 John Combe, York—Drawing fibrous substances
427 T. W. Nicholson, Gracechurch Street—Cylinder printing machines
428 James Ferrabee, Stroud—Feeding carding machines
429 A. V. Newton, Chancery Lane—Water meter.—A com.

16th February, 1867.

430 Edward Lord, Todmorden—Looms for weaving
431 John Shaw, Oldham—Spinning cotton
432 James Carter, Dunfermline—Windows
433 George White, Cheapside—Mathematical instruments.—A com.
434 Henry Cooper, Bunhill Row—Dining table
435 James Parkes, Stockport—Answering instrument
436 Ebenezer Stevens, Middlesex—Securing coal plates
437 Ebenezer Stevens, Middlesex—Cans, kettles, &c.
438 Richard Hodson, West Ham—Machines for punching

18th February, 1867.

439 W. Hill and H. C. Wilberforce, York—Gas-cooking apparatus
440 R. Thwaites, E. H. Carbutt, Bradford, and J. Sturgeon, Burley—Hammers
441 Count Arthur Dillon, Paris—Recovering ships
442 W. H. Harfield, Royal Exchange Buildings—Windlasses
443 W. E. Newton, Chancery Lane—Corsets.—A com.

19th February, 1867.

444 Charles Wenner, Horwich—Preventing down draught in chimneys
445 G. F. Redfern, Finsbury—Fire-arms.—A com.
446 A. A. Fousset, Paris—Treatment of varnished leather
447 Henry Haschke, Watling Street—Fire-arms.—A com.
448 Amand Beniest, Ghent—Governors for steam engines
449 Henry Alder, Edinburgh—Gas meters
450 Edward Brasier, New Cross—Scutching flax
451 Edward Brasier, New Cross—Manufacture of oakum
452 H. Y. D. Scott, Ealing—Constructing the floors of houses
453 A. V. Newton, Chancery Lane—Railroad switch indicator.—A com.

20th February, 1867.

454 William Harrison, Winsford—Consuming smoke
455 Michael Cavanagh, Kensington—Adjustable lock spindles
456 Thomas Archer, Gateshead-on-Tyne—Stone ores
457 J. S. Walker, Wigan—Cutting coal
458 J. H. Johnson, Lincoln's Inn Fields—Obtaining light and heat.—A com.
459 Richard Moreland, St. Luke's—Floors for buildings
460 A. Albini, London, and F. A. Braendlin, Birmingham—Fire-arms
461 Charles Weigand, Pimlico—Umbrellas
462 Robert Kunstmann, City Road—Polishing glass
463 George Haseltine, Chancery Lane—Shutting off gas.—A com.
464 George Haseltine, Chancery Lane—Boat detaching apparatus.—A com.
465 W. R. Lake, Chancery Lane—Files.—A com.
466 Michael Henry, Fleet Street—Balloons.—A com.

21st February, 1867.

467 W. S. Gamble, Stratford—Lubricating apparatus
468 John Bishop, Middlesex—Fire-arms
469 W. B. Adams, Blackheath—Uniting iron and steel
470 George Haseltine, Chancery Lane—Wheels for carriages.—A com.
471 H. Wadkin and C. Shepherd, Chester—Improvements in burning limestone
472 E. G. Brewer, Chancery Lane—Obtaining motive power.—A com.
473 J. M. Kaufmann, Glasgow—Travelling through the air
474 J. Weems, Johnstone, and T. Robertson, Kennishead—Motive power engines
475 John Saintv, Burnham Westgate—Hurdles
476 Bertram Mitford, Cheltenham—Teaching alphabets
477 William Riddell, London—Disintegrating wood
478 John Robinson and John Smith, Rochdale—Applying motive power to saw frames
479 William Hale, Fulham Road—Propelling vessels
480 J. F. Bland, Sandgate—Fire-arms
481 L. H. Mahon, Bayswater—Working designs in wood

22nd February, 1867.

482 J. R. Crompton, Bury—Rag engines
483 M. Walker, G. H. Money, and F. Little, London—Fire-arms
484 John Harrison, Liverpool—Removing sea weed from bottoms of ships
485 W. West and J. Darlington, London—Counterbalancer pump-rod
486 Charles Colwell, Gorleston-cum-Southtown—Obtaining motive power
487 W. W. Urquhart and J. Lindsay, Dundee—Power loom lathes
488 A. I. L. Gordon, Hyde Park—Fastening electric signal wires
489 C. E. Brooman, Fleet Street—Threads.—A com.
490 Joseph Wareing, Birmingham—Cricket spikes
491 C. M. Tate, London—Envelopes
492 William Clark, Chancery Lane—Anhydrous soap.—A com.
493 Michael Henry, Fleet Street—Railway engines.—A com.
494 Charles Kessler, Frankfort-on-Maine—Potash
495 W. E. Heath, Chalk Farm—Gas pressure governors

23rd February, 1867.

496 Thomas King, Spitalfields—Washing casks
497 J. P. Smith, Hereford—Tilling land
498 Henry Purnell, Glasgow—Motive-power engines
499 A. Kinder and W. B. Kinsey, London—Gas engines
500 W. Deakin, Great Barr, and J. B. Johnson, Tettenhall—Steel caps
501 C. G. Gumpel, Leicester Square—Chairs
502 W. P. Gray, Fulham—Fire-arms
503 H. J. Cole, Kennington Cross, and W. C. Horton, Kennington Road—Awnings
504 I. M. Milbank, Connecticut, U. S.—Fire-arms
505 P. A. Muntz, Keresley—Metallic alloys
506 B. Billingham, Bradley, A. Griffiths, Bilston, and J. Dudley, Daisy Bank—Rails
507 John Bates, Eldon Street—Lubricator
508 Charles Turner, Southampton—Brushes
509 C. E. Brooman, Fleet Street—Threads.—A com.

25th February, 1867.

510 Gustav Lüttringhaus, Mülheim—Portemonnaies
511 John Marshall, East Geeenwich—Fluid safety gauges
512 Eugène Chaprou, Luxembourg—Treatment of peat
513 John Cash and Joseph Cash, Coventry—Manufacture of towels
514 J. C. R. Weguelin, Croydon, and B. Hirst, Leeds—Generating steam
515 William Barratt, Bristol—Boiling fats
516 John Alison, Brightlands, Reigate—Steam boilers

26th February, 1867.

517 J. A. & J. Hopkinson, Huddersfield—Furnaces
518 George Daws, Penge—Signalling on railways
519 James Syme, Glasgow—Central fire cartridges
520 W. H. Samson, Underhill—Drying hops
521 H. R. Du Pré, Shellingford—Candlestick
522 W. R. Hill, Lambeth—Dissolving views
523 Edward Funnell, Brighton—Alarum for railways
524 Edward Hely, Dublin—Envelopes
525 George Young, Grangemouth—Lamps
526 J. L. Sharman, Northampton—Boot lasts
527 Clement Martin, Hammersmith—Steam engines
528 J. G. Taylor, Paris—Chains
529 John Tatham, Rochdale—Preparing cotton
530 A. V. Newton, Chancery Lane—Belt fastenings—A com.
531 C. E. Brooman, Fleet Street—Extracting liquids.—A com.
532 C. E. Brooman, Fleet Street—Clock winder.—A com.

27th February, 1867.

533 George Haseltine, Chancery Lane—Covering for horses' feet.—A com.
534 F. V. Wright, Westminster—Reflectors for lamps
535 Andrew Howat, Farnworth—Cutting coal
536 William Stobbs, Leeds—Steam driving wheel
537 J. R. Cooper, Birmingham—Fire-arms
538 J. Saxby and J. S. Farmer, Kilburn—Working railway signals
539 H. A. Bonneville, Bayswater—Deepening rivers and other watercourses.—A com.
540 Thomas Humphreys, Deptford—Fire-lighter
541 William Dyson, Thongsbridge—Twisting threads
542 T. B. Kay and F. Hamilton, Bolton-le-Moors—Carding engines
543 John M'Lintock, Barnsley—Packing for piston rods
544 Samuel Butler, Nottingham—Figured lace
545 L. H. Philbois and A. Marchal, Paris—Springs for crinolines.—A com.
546 A. L. Holley, New York, U. S.—Iron and steel
547 J. Livesey, J. Edwards, and W. Jeffreys, Surrey—Signals and switches
548 Murdoch Mackay, Portsea—Boiling textile fabrics
549 A. V. Newton, Chancery Lane—Railways.—A com.
550 A. V. Newton, Chancery Lane—Screws.—A com.
551 Alexander M'Dougall, Manchester—Utilizing clay

28th February, 1867.

552 C. J. Pownall, London—Ventilating pits
553 Thomas Hyatt, Wolverhampton—Securing door knobs
554 R. E. Guy, Liverpool—Money bags
555 Samuel Shore, Rochdale—Preparing wool
556 A. G. Chalus, Paris—Producing artificial light
557 John Piddington, London—Inkstands.—A com.
558 Andrew M'Callum, Greenock—Actuating motive-power engines
559 A. B. Brown, Wandsworth Road—Steering apparatus
560 S. B. Allen and J. H. Winsor, Massachusetts, U. S.—Generating heat.—A com.
561 E. T. Hughes, Chancery Lane—Sewing machines.—A com.
562 Jacob Buhrer, Munich—Ovens
563 A. A. Croll, Coleman Street—Treatment of hydrocarbon oils
564 Murhall Woolrich, Handley—Cure of 'foot rot' in sheep
565 J. Harbert and F. Goodman, Kidderminster—Destroying explosive gases
566 John Bellerby, York—Grinding grain
567 G. F. Russell, Piccadilly—Wheels
568 William Clark, Chancery Lane—Producing oxygen.—A com.
569 W. E. Newton, Chancery Lane—Spinal supports.—A com.
570 A. V. Newton, Chancery Lane—Cutting veneers.—A com.
571 A. V. Newton, Chancery Lane—Steam engines.—A com.

1st March, 1867.

572 R. A. Jones and J. C. Hedges, Aylesbury—Portable fire escapes
573 J. C. Broadbent, Rochdale—Safety disengaging hook
574 J. H. Johnson, Lincoln's Inn Fields—Sewing textile fabrics.—A com.
575 Theophilus Berrens, Paris—Perforating tunnels
576 C. H. Beckingham, Strand—Billiard tables
577 W. C. Thurgar, Norwich—Regulating the supply of gas
578 Benjamin Sheard, Batley—Furnaces
579 William Parry and J. Frearson, Birmingham—Purifying sewage
580 F. A. P. Vandeputte, Ghent—Regulator for motive engines
581 F. W. Jones, Exeter—Indicating the speed of locomotives
582 J. G. Stidder and R. Morris, Palace Road—Axles and shafts

2nd March, 1867.

583 Max Gossi, Antwerp—Transporting petroleum oil
584 R. Wilson and W. H. Bailey, Manchester—Call bells
585 S. Frank and R. Gooddy, Manchester—Producing selvedge lines
586 John Wild, Oldham—Condensing steam engines
587 E. T. Hughes, Chancery Lane—Filtering presses.—A com.
588 G. M. Garrard, Gracechurch Street—Mowing and reaping
589 A. and H. Illingworth, Bradford—Cops or bobbins
590 Edward Thring, Uppingham—Stoves
591 J. A. Coffey, London—Safety gauges
592 A. C. Laurys, Louvain—Elastic stockings
593 George Haseltine, Chancery Lane—Self-lubricating axle.—A com.
594 W. R. Pape, Newcastle-on-Tyne—Breech-loading fire-arms

4th March, 1867.

595 T. J. Binfield, Deptford—Fastening packages
596 W. E. Gedge, Strand—Flax-stripping machine.—A com.
597 W. E. Gedge, Strand—Water closets.—A com.
598 R. E. Keen, Old Change—Reel frame
599 M. A. F. Mennons, Chancery Lane—Fire-arms.—A com.
600 Edward Deane, London—Tent poles
601 J. Marchent and J. Parker, Bowling—Generating steam
602 R. E. Waddington, Plymouth—Umbrellas
603 J. W. Lewis, Birmingham, and George Archbold, Handsworth—Needle cases
604 Robert Thompson, New Charlton—Shaping mouldings
605 Samuel Newington, Ticehurst—Destroying insects in plants

5th March, 1867.

606 J. M. Stanley, Birmingham—Metallic front for shirts
607 J. C. Martin, Barnes—Packing and preserving animal size
608 Henri Ulliel, Avenue de Neuilly—Artificial light
609 Thomas Beeley, Newton Moor—Boilers or steam generators
610 F. H. Jones, Manchester—Wearing apparel
611 A. S. Macrae, Liverpool—Hydrocarbon oils
612 J. E. Smith, Southwark—Ornamenting collars
613 George Haseltine, Chancery Lane—Packing steam-engine joints.—A com.
614 George Haseltine, Chancery Lane—Feed-water regulator.—A com.
615 G. Withy and J. F. Cotterell, Bath—Bottle cases
616 J. E. Duyck, Glasgow—Utilization of mineral oils
617 George Rowley, Birmingham—Miners' safety lamps
618 E. Wells and W. Pryor, London—Brackets for supporting shelves
619 George Haseltine, Chancery Lane—Fire-arms—A com.

6th March, 1867.

620 J. R. Breckon, Darlington, and R. Dixon, Crook—Screening coke
621 J. G. Tongue, Chancery Lane—Steam engines.—A com.
622 G. H. Morgan, Edgware Road—Carriages
623 W. E. Gedge, Strand—Pianofortes.—A com.
624 John Thompson, Nettlebed—Gas
625 H. C. Ash, London—Cooling and freezing liquids
626 Edward Storey, Lancaster—Boilers
627 H. Barton and E. Whalley, Blackburn—Spinning cotton
628 William Tomlinson, New Mills—Calico printing machines
629 H. W. Hallett, Chancery Lane—Producing optical illusions.—A com.
630 A. V. Newton, Chancery Lane—Couplings.—A com.

7th March, 1867.

631 C. W. Siemens, Westminster—Measuring water
632 George Davies, Serle Street—Insulators.—A com.
633 A. L. Normandy, Stockwell—Heated air engines
634 William Heginbottom, Mixenden—Steam boiler furnaces
635 E. K. Heaps, Leeds, and T. P. Moorwood, Sheffield—Fire ranges
636 I. Dimock, Cheapside, and J. Gresham, Manchester—Sewing machines
637 Alfred Giles, Manchester—Mixing apparatus
638 H. W. Achgelis, Manchester—Bridle bits
639 R. Luke and W. Parkes, Birmingham—Metallic bedsteads
640 Colonel S. Wortley, London—Hatching eggs
641 P. R. Hodge, Cannon Street—Hydraulic motors
642 W. E. Newton, Chancery Lane—Porcelain.—A com.
643 A. V. Newton, Chancery Lane—Safety valves.—A com.
644 W. E. Newton, Chancery Lane—Steam hammers.—A com.
645 J. G. Woodward, Liverpool—Generating steam
646 William Clark, Chancery Lane—Actuating fan blowers.—A com.
647 Edward Lloyd, Bow—Straw paper
648 William Hurrell, Houndsditch—Bushings
649 Benjamin Snow, Massachusetts, U. S.—Scissors.—A com.
650 W. Young, Straiton, and P. Brash, Leith—Distilling bituminous substances
651 W. H. Towers, New York, U. S.—Hardening leather
652 S. C. Salisbury, New York, U. S.—Refining metallic ores

8th March, 1867.

653 Colin Mather, Manchester—Mangling fabrics
654 Frederic Pope, Cheapside—Locks
655 H. Churchman, Horsham, and F. Braby, London—Cleaning boots
656 J. H. Johnson, Lincoln's Inn Fields—Glove fastenings.—A com.
657 James Turner, Stepney—Covering the surface of iron
658 Thomas Cook, Surrey—Sewing machines
659 W. R. Lake, Chancery Lane—Coating paper.—A com.
660 G. H. Daw, London—Cartridges for breech-loaders
661 Charles Mace, Sunderland—Steam boilers
662 Joseph Whitaker, Farsley—Steam boilers
663 Michael Henry, Fleet Street—Measuring ships' speed.—A com.
664 Stephen Hawthorn, Burslem—China knobs
665 T. S. Turnbull, Birmingham—Mourning lockets
666 Joshua Horton, Birmingham—Metallic rollers
667 Gabriel Dümler, Namur—Lamps for burning petroleum
668 James Newman, Small Heath—Tyres for railway wheels
669 J. E. Asselin, Paris—Needle cases.—A com.
670 William Clark, Chancery Lane—Starting carriages.—A com.

9th March, 1867.

671 A. Field, and W. B. Nation, London—Ornamenting candles
672 Lorentz Tidén, Manchester—Railway axle bearings
673 W. S. Lowe, New Mills—Sizing machines
674 Auguste Rupp, Paris—Drying cylinders
675 J. G. Tongue, Chancery Lane—Bridles.—A com.
676 J. S. Gisborne, Liverpool—Protecting needles of mariners' compasses
677 M. A. F. Mennons, London—Fire-arms.—A com.
678 George Glover, Pimlico—Lamps.—A com.
679 R. D. Napier, Limehouse—Steam boilers
680 B. Walker and J. F. A. Pflaum, Leeds—Crushing stones

11th March, 1867.

681 Adam Millar, London—Marking the prices of goods
682 H. C. Hill, Staleybridge—Winding yarn
683 Michael Cavanagh, Kensington—Sash fastening
684 H. A. Bonneville, Bayswater—Preserving solutions of plants.—A com.
685 J. J. Blackham, Birmingham—Brooch fastenings
686 W. B. Nation, Surrey—Raising, forcing, and propelling fluids
687 Alonzo Kimball, Glasgow—Sewing machines
688 Frederick Ryding, Limerick—Baking vulcanite
689 Pierre Duchamp, Lyons—Stopping bottles
690 Joseph Pearson, Birmingham—Ball valves
691 J. B. Fenby, Birmingham—Connecting door knobs to spindles
692 E. T. Hughes, Chancery Lane—Economizing gas, petroleum, and oils.—A com.
693 William Dempsey, Congleton—Spinning silk
694 Donald Nicoll, Kilburn—Electric telegraph conductors
695 William Akers, Sussex—Construction of horse-shoes
696 M. P. W. Boulton, Tew Park—Propulsion
697 Matthew Chamberlaine, Surrey—Washing machines
698 William Clark, Chancery Lane—Drying threads.—A com.
699 M. J. E. Jullienne, Paris—Bath belts

12th March, 1867.

700 Robert Wilson, Patricroft—Motive-power engines
701 L. C. Sodeman, Shoreditch—Fastening and unfastening stays' busks
702 Thomas Burt, Wandsworth—Moving mud.—A com.
703 B. P. Walker, Wolverhampton—Steam engine valves
704 H. L. Corlett, Inchicore—Buffing springs
705 Thomas Hatton, Brighton—Pictures for magic lanterns
706 A. Parkinson and D. Sweaney, Manchester—Slop pail and night commode
707 J. F. Brinjes, Whitechapel—Reburning of animal charcoal
708 John Fox, West Hackney—Filters
709 Charles Maschwitz, Birmingham—Taps and valves.—A com.
710 J. A. Fussell, Birmingham—Hat and coat hooks
711 William Trimble, Glasgow—Preparing flax
712 William Hall, Bradford—Winding yarns
713 J. L. Norton, London—Washing wool
714 William Wood, Monkhill—Grinding rags

13th March, 1867.

715 J. Willcock, Stockport, and S. Mason, Manchester—Wheel moulding machines
716 W. J. Sleath and J. Hargreaves, Bacup—Healds employed in looms
717 M. A. F. Mennons, London—Fire-arms.—A com.
718 Justin Thevenet, Belgium—Slide valves of steam engines
719 John Boyd, Glasgow—Looms
720 T. Walker and T. F. Walker, Birmingham—Measuring the flow of liquids
721 John Hamilton, Glasgow—Producing gas
722 W. E. Newton, Chancery Lane—Ventilation of theatres and churches, and purifying and cooling the air supplied thereto.—A com.
723 F. R. A. Glover, Brading—Ships' anchors
724 Michael Henry, Fleet Street—Supplying beer.—A com.
725 G. Rumbelow and H. Kendall, Bury St. Edmunds—Rollers
726 William Wootton, Surrey—Candlestick sockets
727 J. Griffith, Menai Bridge—Working ships' pumps
728 Benjamin Platt, Liverpool—Manufacture of chloride of lime
729 J. C. Morrell, Leyland—Dry closets
730 W. Esplen and J. J. B. Bland, Liverpool—Signalling apparatus
731 M. F. Halliday, Kensington—Fire-arms
732 Edward Lee, High Holborn—Producing pictures upon glass
733 William Read, Newton Heath—Excavating coal

14th March, 1867.

734 Hugh Smith, Much Hadham—Preparing turnips for animals
735 Samuel Clarke, Albany Street—Candlesticks
736 J. B. Dancer, Manchester—Ascertaining the speed of machinery
737 W. G. Blagden, London—Extracting silver.—A com.
738 P. T. Goodwin, Camden Street—Retorts
739 James Ferguson, Helensburgh—Applying screw propellers
740 W. E. Newton, Chancery Lane—Butter boxes.—A com.
741 W. Hamer, Manchester, and J. Davies, Bowdon—Supplying heated air to furnaces
742 J. P. Baragwanath, London—Cramping apparatus.—A com.

15th March, 1867.

743 J. Keymer and W. Whitehead, Dartford—Dyeing and printing
744 J. R. Parkinson, Blackburn—Varnish for healds of looms
745 J. Westwood, London, and R. Baillie, Leyton—Protecting iron ships from corrosion
746 W. H. Graveley and J. Ewing, London—Steam cooking apparatus
747 E. P. Plenty, Newbury—Marine steam engines
748 J. H. Johnson, Lincoln's Inn Fields—Dyeing carded wool.—A com.
749 Percy Crause, Dorset Square—Propelling vessels
750 W. E. Newton, Chancery Lane—Spinning machinery.—A com.
751 A. V. Newton, Chancery Lane—Bale tie.—A com.
752 George Smith, Leeds—Soap for scouring wool
753 Nathan Thompson, London—Connecting the ends of pipes
754 J. P. Harper, Derby—Mining cages, hoists, and lifts
755 W. R. Lake, Chancery Lane—Rotary engines.—A com.

16th March, 1867.

756 Thomas Cowburn, Manchester—Safety valves
757 Thomas Dunn, Pendleton—Boilers for generating steam
758 Emile Nougaret, Paris—Pouncing hats
759 John Milner, Strand—Slide valves for steam engines
760 W. R. Harris, Manchester—Improved belt hook
761 M. A. F. Mennons, London—Fire-arms.—A com.
762 John Grundy, Wolstenholme Hall—Prevention of smoke
763 John Kennedy, Glasgow—Annealing cast-iron articles
764 Guybon Hutson, Glasgow—Steering apparatus
765 Richard Canham, Clerkenwell—Sharpening knives
766 James Hickisson, Southgate Road—Biscuits
767 Stephen Holness, Victoria Park—Rotating brushes
768 Thomas Shedden, Ardgarton House—Fire-arms
769 A. V. Newton, Chancery Lane—Fire-arms.—A com.
770 A. J. H. Elliot—Working machinery
771 E. E. Allen, Parliament Street—Steam engines
772 James Shand, Blackfriars Road—Steam fire engines

18th March, 1867.

773 W. H. Bailey, Salford—Travelling trunk, bath, and cradle
774 John Smith, High Crompton—Cleaning waste
775 T. W. Nicholson, London—Lithographic stone grinding
776 F. H. Wenham, Clapham—Heated air engines
777 H. J. Newcome, London—Warming buildings
778 Henry Simms, Bath—Pianofortes
779 W. H. Parsons, Swansea—Setting boilers
780 D. Ellis and M. Hillas, Dudley Hill—Weaving
781 Joseph Smith, Birmingham—Gun locks
782 A. W. Moore and E. M'Neal, Holloway—Spring shank for boots

19th March, 1867.

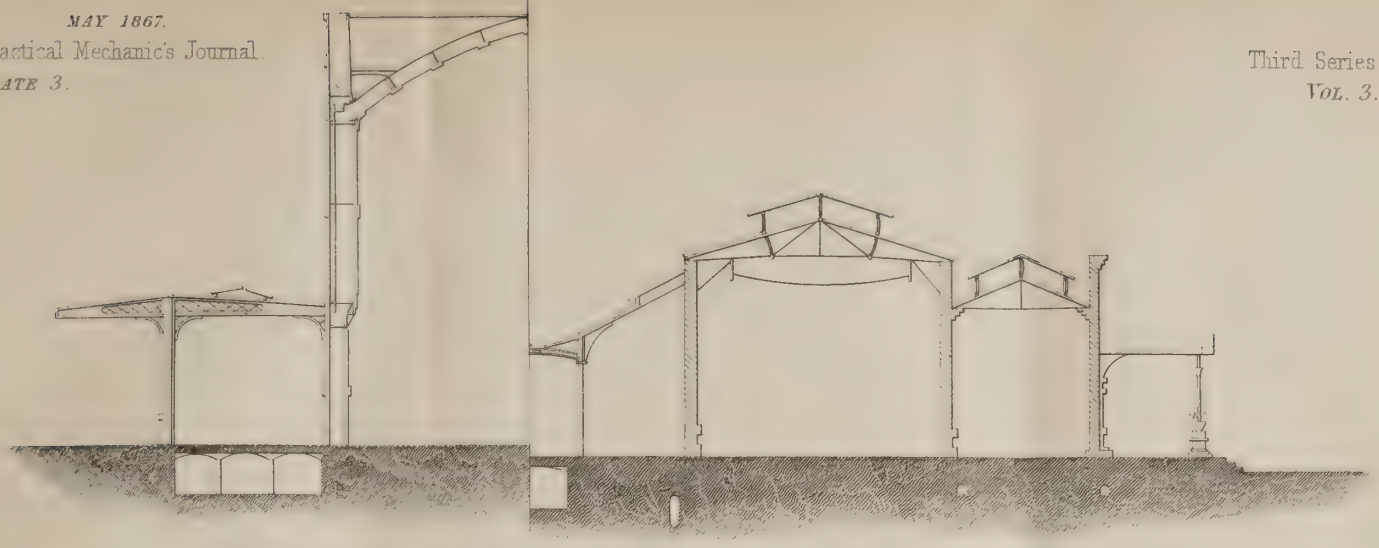
783 John Robinson, Greenfield—Steam boilers and engines
784 Edwin Harvie, Islington—Raising carriage heads
785 C. F. Cooke, York—Safety valves
786 J. C. H. Sievier, Upper Holloway—Construction of ordnance
787 Francis Gregory, Salford—Apparatus used in breweries
788 A. H. Hart, London, and William Parry, Birmingham—Purifying sewage
789 Christian Allhusen, Newcastle-upon-Tyne—Treating small pyrites
790 James Hislop, Ayr—'Scurfing' gas retorts
791 Matthew Semple, Axminster—Warming buildings
792 A. V. Newton, Chancery Lane—Sewing machines.—A com.
793 J. M. Clements, Birmingham—Ironing and damping machinery
794 A. S. Cameron, New York, U. S.—Protected safety valves
795 J. H. Johnson, Lincoln's Inn Fields—Printing hanks of silk—A com.
796 Thomas Aveling, Rochester—Road rollers
797 W. M'Adam and S. Schuman, Glasgow—Casing for protecting bottles
798 E. L. Sturtevant, Boston, U. S.—Breech-loading fire-arms
799 William Clark, Chancery Lane—Disaggregation of china grass.—A com.
800 John Portlock, South Molton Street—Operating the extractor of guns

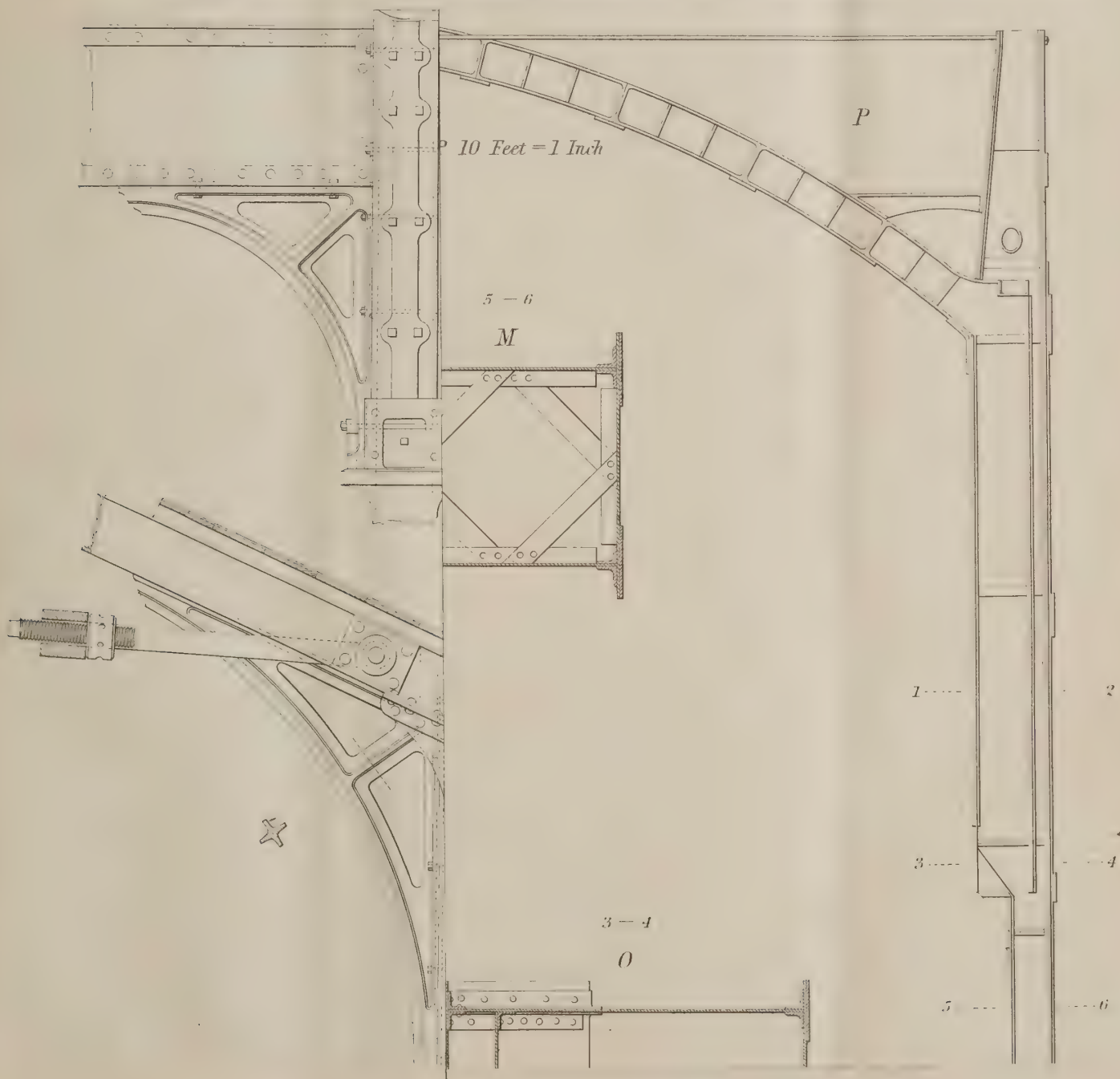
20th March, 1867.

801 R. H. Collyer, France—Treating flax
802 P. T. Goodwin, Camden Street—Driving revolving retorts
803 J. W. Yates, Birmingham—Handles of spades
804 T. K. Mace, Birmingham—Securing door knobs to spindles
805 M. A. F. Mennons, Southampton Buildings—Central-fire cartridges.—A com.
806 S. M. Tyler, Brooklyn, U. S.—Sewing machines
807 G. A. Laurent, France—Preventing accidents on railways
808 B. J. Smith, Eton—Protecting watches
809 J. R. Swann, Edinburgh—Steam boilers
810 Gustav Bischof, Prussia—Coating metals
811 George Chambers, Northampton—Exhibiting cloths and fabrics
812 John Leeming, Bradford—Looms for weaving

21st March, 1867.

813 D. Y. Stewart, Glasgow—Casting iron pipes
814 G. E. Marchisio, Baker Street—Application of isolating compositions
815 James Booth, Halifax—Textile fabrics
816 J. H. Simpson, Kilmeena—Printing telegraphs
817 Henry Clifton, New Bond Street—Coolers for wine
818 Henry Clifton, New Bond Street—Refrigerators
819 James Greenshields, Glasgow—Compound for the production of gas
820 William Clark, Chancery Lane—Central-fire cartridges.—A com.
821 Leonard Latter, Catford Bridge—Brakes for common road carriages
822 J. A. Limbert, Gravesend—Raising, lowering, and moving heavy bodies
823 William Lorberg, Chelsea—Construction of urinals
824 W. E. Newton, Chancery Lane—Chronometers.—A com.
825 H. W. Hart, Springwell Lodge—Producing indestructible photographic pictures
826 W. D. Player, Birmingham—Covers for the tops of bottles
827 G. Haseltine, Southampton Buildings—Heating and ventilating apparatus.—A com.




P
10 Feet = 1 Inch
5 — 6
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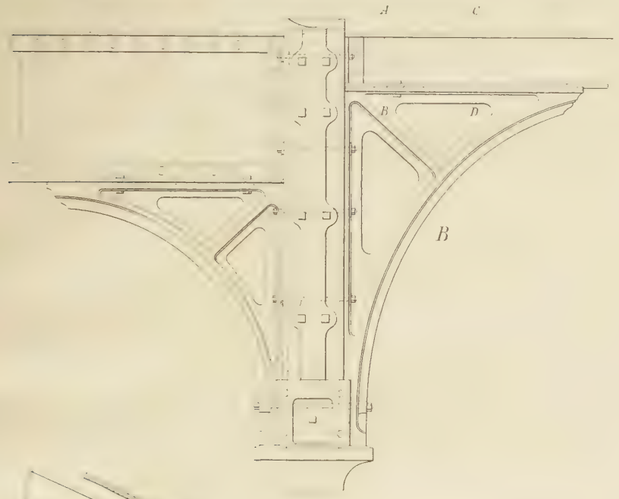
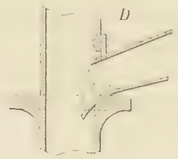
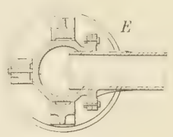
PARIS EXHIBITION
1867.

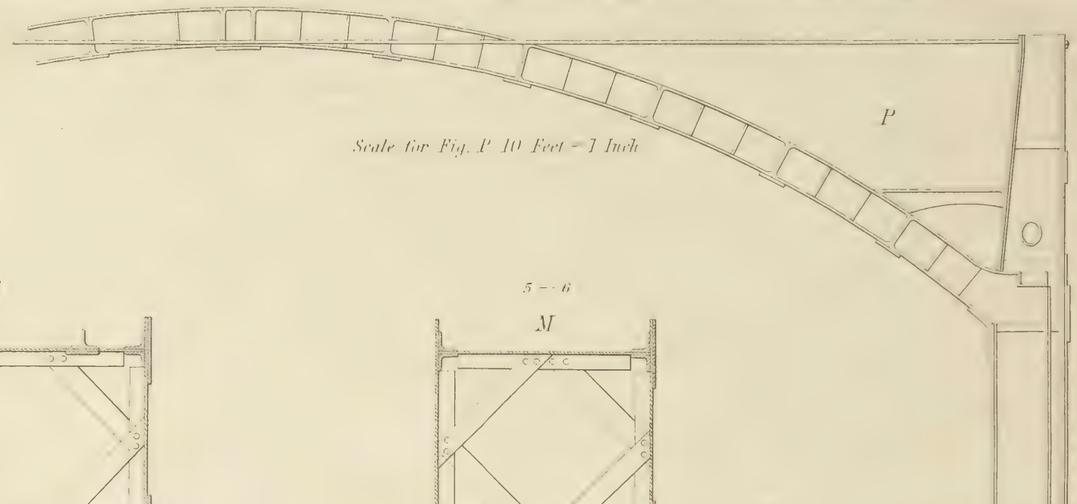
Scale for Fig. A about 36 Feet = 1 Inch.

A

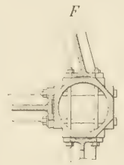


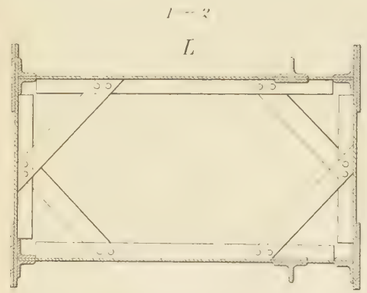


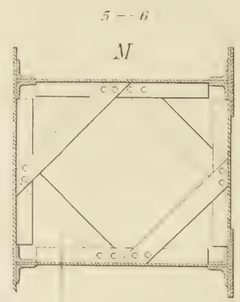




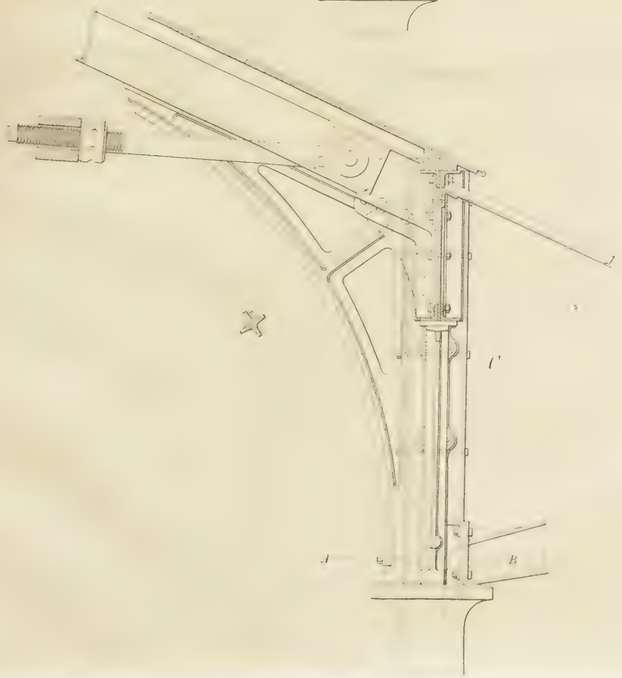
Scale for Fig. P 10 Feet = 1 Inch

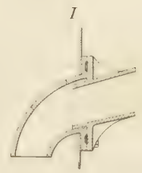


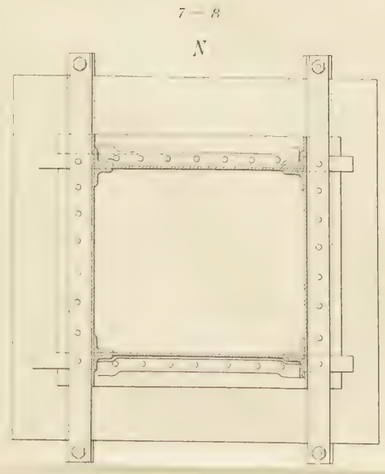


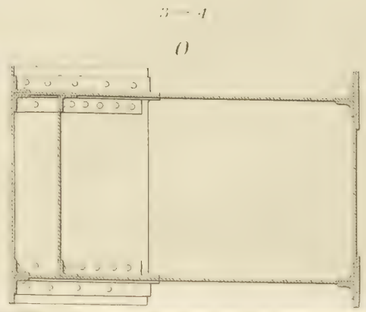


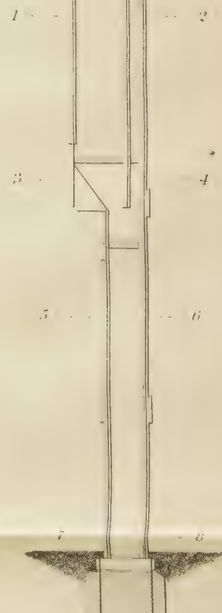
Scale ½ Inch = 1 Foot











Patent Offices 47 Lincoln's Inn Fields London
and 166 Buchanan St Glasgow

THE PARIS EXHIBITION OF 1867.—THE GENERAL ARRANGEMENTS AND BUILDING.

Plates Nos. 2 and 3 of our present Part give a general plan of this great building and of the so-called park or large space of ground surrounding it, which completes the rectangle of the Champ de Mars as it originally stood, and which is now densely filled with a number of detached buildings of the most varied uses or intentions, and, we may truly say, of the most diverse and incongruous designs in too many cases. The Exhibition, viewed as a whole, is, however, not confined even to these vast dimensions. A pretty broad and long strip of ground close down to the water's edge of the river Seine, to the north of the quay or public road, and stretching up and down the river at either end of the Pont de Jena (which is the great approach to the exhibition from the north of Paris), has been devoted as an annexe to the exhibition of marine engines and other machinery. This is approached by a brick tunnel constructed from the park under the public quay or roadway. Besides all this, a very large plot of ground has been set apart at Billancourt, lower down the river by nearly a mile, for the exhibition of agricultural machinery, instruments, and produce; and this space is intended to be sufficient to afford the means of actual experiments in steam ploughing, machine mowing, haymaking, &c., during the summer. Thus, taking all together, there is probably not less than from fifty to sixty statute acres of ground devoted in one shape or other to the purposes of this the largest exhibition that has ever yet been arranged. The Exhibition building itself consists in plan (Plate 2) of two semicircles, connected by a rectangle embraced between them, and whose length is equal to the diameters of the semicircles. It is therefore incorrect to speak of it, as is frequently done, as a great ellipse, and as being a reproduction of the form and the general idea of the ancient Roman amphitheatre. It has a rude resemblance to the ellipse in form, but there all resemblance ends; and the ellipse was, for excellent constructive reasons, avoided, because, while *all* the parts of any given *sector* of a circular building, as to roofing, &c., are similar, none but those of two respectively opposite sectors of an elliptic building are so, and even of these the respective parts are only similar when taken as diagonally opposites of a given diameter. Hence great complications and difficulties and delays would be encountered in adapting metallic parts to an elliptic building. It has also been stated, and upon assumed authority, that the cruciform plan given to the building has been necessary in order to adapt it to the peculiar arrangement of the contents, here for the first time fully adopted, and to which, it has been stated, almost everything else has been sacrificed.

The peculiarity of arrangement consists in this, that the whole space within the building is cut up into gores or sector-shaped bands of various widths, and divided amongst the exhibiting nations. Each one of these sectors has its contents classified and arranged in zones of like width, and at like distances from the centre. The effect of this is, that the observer who wishes to see in succession all the varied products of one given nation, may traverse the sector in a *radial* direction, and so see these one after the other in a determinate order, and in the same for all the sectors or nations. But if he wants to examine all the like products of several nations, or of the whole of those who exhibit, he must walk circumferentially round the building (or rather one zone of it) at a determinate and constant distance from the centre. Thus, if he be in the machinery zone, he may go quite round, and will find in succession all the machinery of all the nations in the whole exhibition; so by the fine art galleries, the raw products, &c. The primary idea here carried out, then, is obviously based simply upon the crossing of two sets of ordinates and of abscissæ—the ordinates representing *quality* or kind, and the abscissæ *locality* or place. And it is as obvious that this idea could have been just as easily carried out, if not even better carried out, in a building rectangular in plan than in one of the form chosen. In fact, one plan* was actually forwarded to the commissioners of 1851, in reply to the circular, with lithograph of the intended site in the park, asking for suggestions as to the building, in which this very idea of classification was, we understand, embraced. The building proposed was to consist of a number of parallel long rectangular sheds, one for each nation exhibiting. The products of every nation were to be arranged in similar order, starting from one and the same end of all these sheds, whose respective areas were to be by reduction, &c., of width, proportioned to the demand for space by the occupying nation. Then, following the length of the sheds, up one, down another, the visitor saw each nation's goods in succession or the whole exhibition; but by following transverse passages connecting all the sheds together, at the dividing lines of their respective products, the visitor had the power to see all like products of all the world's producers. That plan, like many others, was heard no more about, and, no doubt, because it was thought utilitarian merely, and lacked "a grand feature," which, it will be remembered, was deemed an indispensable for the building of 1851, which was projected being met at first by a gigantic and useless central iron dome, and which was at last met, as by a *deus ex machina*, by the happy thought of Mr. Paxton's great glass house. There is therefore absolutely nothing new in the French arrangement in suggestion of principle. No doubt, the notion of the necessity for something imposing in feature and novel in conception was that which weighed chiefly in determining the curvilinear form of plan, with possibly a sort of vague notion that something of the Colosseum ground plan might most suit the imperial taste of the master of the whole display.

* By Mr. R. Mallet, C.E.

There is no doubt, however, that the form adopted fits the area of the Champ de Mars very suitably, and leaves a cincture all round, even at the sides where it is narrowest, which *might* have been made to form a very beautiful garden, with space enough and to spare to have enjoyed the real repose and pleasure of grass, and shrubs, and flowers, and fountains, &c., into which it would have been delightful to have gotten out of the heat and turmoil of the whirring and moving objects, and the tread of restless masses within the building. All that, however, has been lost sight of and sacrificed to filling up what ought to have been and still is called (as it were in mockery) the park, with a maze of buildings of every and of no style, intended for all sorts of purposes, which are so thickly studded and so utterly inharmonious as to break up all repose, and to be offensive to all good taste. In one word, the so-called park is a gigantic Cremorne, and in point of style in most parts, only more vast and costly, but not equal in taste to the Jardin Mabille.

Referring to Plate No. 2, the ground plan (on which all this is discoverable), and to the general section, Fig. A, Plate No. 3, which we also now give, the details of plan of the structure may be made clear to the reader. It will be seen that the entire area of the building is made up of no less than nine consecutive and parallel zones or galleries, independent of the central oblong and round-ended space which is called the central garden. We shall take these in succession, and briefly describe them and their respective uses, premising that the whole area of the building is about 1800 feet by 1300 feet, the semicircles being 1300 feet or so diameter each, and the uniting rectangles about 1300 feet by 500 feet; that its long axis runs from the centre line of the Pont de Jena to the centre of the façade of the Ecole Polytechnique; that the grand avenue of approach is in this line from the bridge just named; and that in line with these is the so-called vestibule, or grand axial avenue, reaching to the very centre of the building, and in height equal to the great machinery zone. This, which is in reality as wide, long, and lofty as the nave of many large cathedrals, is but a small feature in the vast covered area. Upon one side of it the visitor will find the productions of France, and upon the other those of Great Britain.

Approaching from the park we have (see section) a covered promenade or asphalted walk, the roof overhanging upon cantilevers, with a projection or width of nearly 24 feet. This runs the whole way round the building, a total length of more than an English mile. At the eave, at intervals of about 10 yards or so, are pendant globes of white opaline glass, protecting gas lights; and there can be little doubt that the effect of these vast curves of lights seen sweeping round of a summer night will be very pretty; for although the building itself is to be closed at 6 p.m., the park and all the pleasant places we are about to notice in the first and second zones are to remain open until 10 p.m.

Looking outwards from this verandah, we have a broad gravelled carriage road, and beneath its surface a double line of rails running round the whole cincture at about a breadth of 40 feet, and connecting by numerous and curved roads and walks with all the other parts and intricacies of the park.

Turning round towards the centre of the building, we have next to us the second belt (so to say) of the outer zone, the *Vestibule des Aliments*, or, in other words, a continuous *enceinte* of *cafés, restaurants*, refreshment rooms—English, Dutch, German, Russian, and what besides—with *brasseries*, beer and porter bars, and no end of the like;

as may well be imagined, when it is remembered that altogether the wing is about as long as one side of Oxford Street. This zone is about 32 feet wide, and the cafés are about 26 feet in height to the flat ceilings, and of various lengths; and some of them constitute very noble apartments, and when French taste shall have done all, will, some at least, prove very handsome indeed. The floors are all of béton, and are, except in one English refreshment room, without matting or carpet, and so far are cold, but that will not be felt as the summer advances. The ground beneath this zone is excavated all round to a depth of about 9 feet, and arched over in three small spans by flat arches, so as to leave a continuous air gallery round beneath the floor level. The object of this is to supply ventilation, not only to the zone of refreshments itself, but to the great machinery zone next within it. Through this transversely, too, penetrate all the steam pipes and water pipes, from the park into the machinery zone, and as respects water, into the very heart of the building. Next within we have the great machinery zone, the largest and in some respects the most important in the entire building. It is about 114 feet wide, and about 80 feet high, to the centre of the arched roof.

This zone is constructed of plate-iron vertical members, rectangular in general section, set upon brick footings, at from 30 to 40 feet apart, from shoulders upon which towards the top the hollow tubular plate-iron arches of the roof spring. These are connected longitudinally by I-sectioned plate-iron purlins, and the whole covered in by heavy corrugated sheet iron. The uprights rise several feet above the springing level of the roof, and are connected by a system of cast-iron stiffening arched framing, with the arched girders of the roof. By this means thrust is removed, and the necessity for any interval tie-rods, &c., obviated. The rain water is taken down through the uprights into the system of sewers beneath the building floor; and no more complete refutation probably need be given of the popular notion that the building is intended to be *permanent*, than the fact that the rain water is let to pass down directly through and in the interior of these uprights of only about $\frac{5}{16}$ plate iron, without any lining tubes or other protection from its corrosive effects whatever. This would suffice in about five years to corrode these uprights into holes. The building is assuredly not intended to abide permanently where it stands, but possibly parts of it may be employed for government constructions elsewhere.

Between each pair of uprights at each side are triple round-headed windows, of iron frames and plain glass; the cills about 27 feet from the ground, and made in part to open. These are the only and fully sufficient lights to this zone. Indeed, the light is rather too much even now, and with great advantage in the English quarter the windows at the outer side have been filled in by translucent calico blinds, painted with divers emblematic designs, but of the taste, choice, and execution of which, the less said the better. One of them, that intended to be suggestive of the great Staffordshire pottery trade, is in the exact style and chiefly suggestive of those celebrated cartoons of "Ye manners and customs of ye Englyshe" in our great and good-tempered contemporary, *Punch*. This is about the only mistake, however, our British executive has made; and we are bound in sober fairness only to say, that nothing can be better than the way in which its officers have discharged their harrassing duties, in the arrangements of the British sections of the Exhibition generally. In the centre of the breadth of the great machinery zone, a gallery of about 15 feet wide runs right round the whole, at about the same number of feet from the ground. This, which is not shown on our Plate, consists of cast-iron columns and coupled columns at intervals, carrying very light but deep latticed girders. It is floored with wood, dove-jointed, and has a plain wrought-iron railway and oaken handrail. It is approached by two grand staircases to the right and left of the great entrance, and by many subordinate lateral, winding staircases, with oaken treads, all very convenient. Stiffness is given to the whole, viewed as a piece of framing, by angle brackets, which are rigidly connected in vertical cross and longitudinal planes with the lattice girders; and upon like brackets, projecting forward at both sides of the gallery, run the lines of shafting which are driven by the several engines in the various nations, and which actuate the machinery exhibited in motion. When this shafting passes round the curvilinear parts of the zone, its lengths meeting at angles of about 15° to 20° are united in some cases by bevel gear, but chiefly by a form of universal or hooker joint. From this gallery, round which the Emperor and Empress walked upon the opening day, a capital *vue generale* of the machinery zone is obtained. The flooring of this zone is of fir planking, about 1 inch thick, close laid. Two lines of permanent railway run quite round near the sides; and the tops of the rails are placed at just such a level that they can be, and are now, covered up by rectangular traps, or plates of flooring formed into panels and dropped into place, ready to be taken up when the rails shall have to be again got into use next autumn, to remove the vast mass of material collected here.

From circumstances connected with the nature of the ground, and want of a hollow base beneath this building, the system of open floor, such as we employed in 1851 and 1862, would have been quite inapplicable. Now that the main mass of dust and rubbish has been cleared, it need not be apprehended that there will be any difficulties in keeping the floor, &c., clear of dust, by the aid of the brush and sweeping machines, and plenty of water for sprinkling.

Proceeding still inward towards the centre, we have next to the great machinery zone, that for *matières premières et des produits bruts*, or, as we less accurately call them, raw products. This is about 30 feet wide, and as many high, and is only separated by a range of columns from the wider space of this same zone, whose width is about 45 feet by 30 feet in height. The roofing upon cast-iron cylindric columns consists all of latticed frames; and the lights are all from the top ridge and furrow skylights, with spaces at ends or edges for ventilation.

Next within this we come to one of the three narrow zones, intended as avenues of circulation only; these are about 15 feet wide, by rather more than 20 feet high; have arched gallery passages for the introduction of fresh air passing right round beneath them, which are also intended for the removal of dust, &c., passed down through the ventilating floor gratings which occur at frequent intervals, and are so arranged as to roofing as to receive the rain water from the roofs of the zones at either side of them, and to transmit this down through the columns and into the lines of secondary sewers that run close to the latter all round, and which connect with the great sewers, big enough for a man to creep through, which lead out of the building and discharge into the Seine river. Still passing inwards, the fifth zone (omitting as zones those galleries of circumferential circulation), which, like the sixth and next, is about 22 feet in height by about 75 feet wide, is devoted to textile fabrics, clothing, and generally to all that relates to manufactures or arts for *personal* use. The sixth zone is dedicated to all such as appertain to the *domestic* use, or to the dwelling and house and the furniture thereof. These zones are roofed with a common form of T iron and tie bar roofing, lighted by skylights at the eaves, and at the centre or ridge; the latter thrown up on louvres for egress ventilation. We have then beyond the sixth zone, and the (*couloir de service*) gallery of circulation interior to it, a narrow zone of about 20 feet in width, having the wall of the picture galleries at one side, which is destined for applications of the liberal arts; that is to say, to photography, stationery, books, binding, and a thousand and one such like. And then we come to the eighth zone, which forms the grand gallery of fine arts—a vast wing of sculpture and painting going right round, with a breadth of nearly 50 feet, and a practical wall height of about 30 feet, lighted and ventilated from the top, and with calico-awning blinds (in some of the nations, and ultimately, no doubt, in all) to moderate and adjust the light.

In the French gallery these are practically very good, but in appearance singularly ugly and clumsy. The floors here, like as in all the other zones except the machinery, are of béton, without matting, except in our own English gallery, where cocoa matting gives an appearance of comfort, but raises a perpetual dust.

Inside this again is the narrower gallery, of about 25 feet in width and 26 in height, also walled at both sides, and lighted from the top like the last, which forms the *Musée Archæologique*, and which will not only comprise all the antiquarianism of the display, and all the implements of devotion to which priests and ritualists delight in giving absurd names, but will contain the collection of objects of art manufacture, so arranged as to show a visible narrative of the rise and progress of human industry in its historical and geographical aspects. This so far is very incomplete; but to the thoughtful man few parts of the great whole will probably present more stirring food for reflection, or more stimulus to the imagination.

We have now got to the inside and last zone, properly so called; and find within this again another or interior verandah, looking inwards, or towards the central garden. This covers, at a width of about 18 feet, a covered and béton-floored esplanade, which, adorned with

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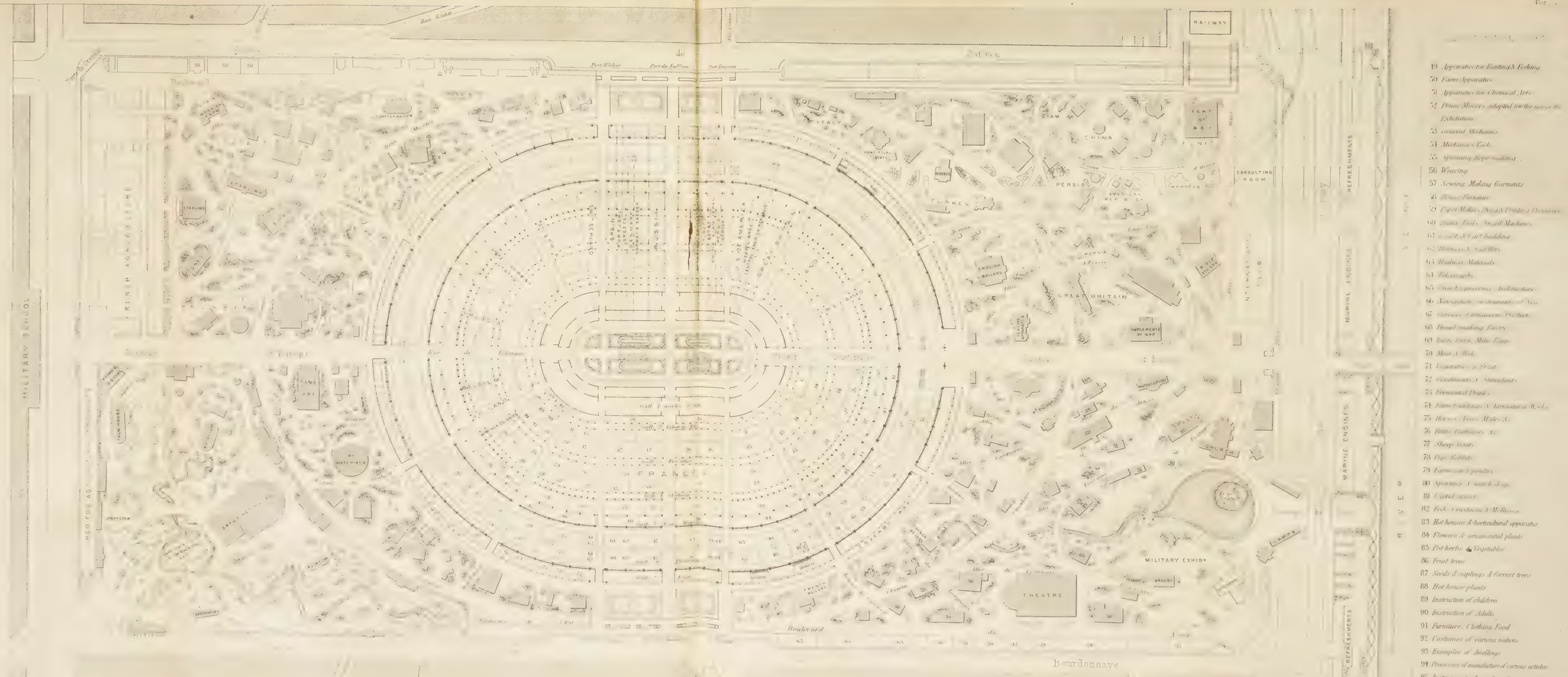
FRENCH EXHIBITION 186_ GENERAL PLAN



sculpture, &c., along its interior or wall side, and with large and massive folded curtains of some heavy cotton or hempen material, of a dull agreeable green colour, capable of being looped up in grand curves and folds, or let down to screen out the mid-day summer sun of Paris at the other or marginal side. Sunk two or three steps beneath this verandah floor, but not nearly enough to have produced its best effect, we now look out upon the central garden. This is an oblong with rounded ends of about 475 feet by about 135 feet, laid out as a sort of Pompeian garden, with gravelled walks, statues, four long fountain basins, and a central circular building with a glazed dome and projecting verandah, intended probably as an orchestra. We have now led the reader, zone by zone, from the exterior to the very heart of the great building. It remains only to say that, at right angles to the great axial avenue which leads right through from the Pont de Jena to the Ecole Polytechnique ends of the structure, there are at right angles to this three great transverse *parallel* avenues, one central and two lateral to this, which pass as it were from one side to the other of the Champ de Mars. Besides these are eight great radial avenues penetrating from circumference to centre. Upon the whole, nothing need be demanded more convenient than the arrangement throughout.

The steam boilers to supply the engines within the building are all placed in isolated buildings in the park, and the pipes go thence in dry culverts under the surface. The supply of steam in the British department seems so far good and ample. The British steam boilers are mainly of the Galloway form, are set under the surface level, so as to be out of direct sight, and placed under a queer roof, and supported (apparently) upon terra cotta columns. This is said to be intended for a reproduction, in part at least, of the Mosque of Syud Oosman at Ahmedabad, and is ugly enough to have come from any barbarous region. As a piece of construction we should not be surprised to hear that it had been blown down before the summer be ended. The French boilers are of different forms, of which we have given illustrations of the two principal in figs. 1, 2, 3, and 4 in this Part, and a more particular description of which will be found in another page of this Part.

It is unnecessary for us to attempt to describe here the greater part of the buildings which crowd the so-called park. Belgium has amongst these a noble picture gallery to herself. In wooden sheds in the British Park will be displayed all our British ordnance and munitions of war. Some of the erections, such as the iron lighthouse for New Caledonia, to show electric light during the Exhibition, are worthy of further description as works. Some, such as the Egyptian Temples, and some other semi-barbarous monstrosities, are best passed by with as little note as may be. Some, such as the Emperor's Pavilion to the left of the grand avenue approaching from the Pont de Jena, and the Pavilion for the Executive and the Juries, which is placed close to the Porte Rapp, at the east side of the park, are necessary parts of the bureaucracy of the Exhibition.

The general constructive plan and detail of construction of the building will have been made pretty clear by what we have already described. The vertical portions of the building are either wrought-iron square, or cast-iron cylindrical, uprights or columns, filled in between where necessary, with rubble stone walls, set in plaster and smooth coated, as are also the walls of the picture and other galleries, &c. The surface of the roofing is either glass, or corrugated iron, or zinc, laid on timber. It has been painted several coats: the great machinery zone is finished a sort of dead dark amber colour, and does not look amiss, picked out as it is here and there with a red brown. The walls of the French Fine Arts zone are toned in red; our English part of the zone a dull sombre gray green. Of minute constructive details there is really very little to say. Simplicity has been studied, and suitability of means to end, before all else. There are no *tours de force*, nor any attempts at those ridiculous pieces of "masterly ingenuity and originality" such as were to be seen in 1862, in the spreading and ricketty roofing of naves and annexes. Nowhere is any failure perceptible, but nowhere is there anything but a sober adherence to proved and accepted models of structure, with a rigid economy of material almost everywhere perceptible to the practical and practised eye of the engineer. The half-sectional elevation, fig. P, Plate, shows clearly enough the general construction of one upright and curved principal of the machinery zone.

Figs. L, M, N, and O, are enlarged sections of the uprights, at the places marked respectively across the elevation at 1—2, 5—6, 7—8, and 3—4. Figs. B to K inclusive, give enlarged details of the structural arrangements, chiefly in cast iron, of the intermediate zones, viz. the 5th and 6th, as already described. Fig. B is an elevation and part section of the upper part of the cast-iron columns, with the longitudinal girders, and stiffening brackets connecting these taken in the plane of these girders; fig. H being a section of the girder at the place G H, and fig. G, further in on the bracket at the place E F. Fig. C is an elevation of the connection between the upper part of the columns, and the brackets, &c., beneath the roof principals of the zones 5th and 6th. In this the mode of adjustment of the tie bars is seen, and also the connection established between the trough-shaped cast-iron arched girders, which are seen passing over the small galleries of circulation between these zones, and which receive the rain water from the roofs, and transmit that down through the columns. The supporting columns of the 4th zone are square in section, as seen in fig. 1, and figs. I and K show the mode of connection of these trough girders with those square columns; while figs. D and E show the like connection with the round ones, which is again partly seen in the elevation, fig. C; fig. E being a horizontal section at A B, and fig. D a vertical partial, through the axis of the columns, and in the plane of the trough girder. Fig. F is a horizontal section, and shows the mode of bolting of the brackets to and through the columns. These bolts are kept above the trickling of rain water, but would not last very long, however, in the damp atmosphere in which they will thus be constantly kept.

It is probable that many minds have been concerned in the design of this great edifice. It is stated, however, that a leading part, both in the designs and in the direction and energetic pushing on to completion of the building, is due to Mons. Krantz, Ingénieur en Chef des Ponts et Chaussées. The work, so far as the metallic parts are concerned, was divided between Cail & Co. and several other of the great mechanical engineering firms in the neighbourhood of Paris. The castings were made, we believe, chiefly in the Departments. The works of the park have been under the direction of Mons. Alphaud, Ingénieur en Chef des Plantations et des Places Publique de la Ville de Paris. None of the bizarrerie, however, can probably be justly laid to his account; for as each nation has had a certain portion of ground allotted to it, so its executive has done just what they thought proper within their own boundaries. The earthwork in the park and for the building alone is said to have amounted to not far short of half a million of cubic yards, and the masonry to about 60,000 cubic yards. The wrought and cast iron work of the skeleton is stated to have involved about 14,000 tons, and this is, we believe, exclusive of the raised gallery in the machinery zone, which has from its nature taken a very considerable additional weight.

Upon the 3rd April, 1867, the Exhibition was formally opened, as had been long before arranged, by the emperor and empress in person, attended by the French executive and by a large cortege of men eminent by station or ability, but with no more pomp or circumstance than are unavoidable in the head of a great monarchy upon such an occasion. But though open now for several days at the time we write this, the arrangement is far from complete, and in many respects it cannot be expected to be so before probably about the period that these lines reach our readers' hands. Meanwhile, officially or formally the work of the juries is *supposed* to be proceeding, but we have reason to believe nothing is in fact being done in the way of adjudication; in fact, to proceed with such in the face of the state which an unusually bad and backward season and weather, and untoward circumstances of various other sorts, have imposed, would be to do injustice alike to the Exhibition and to exhibitors.—Ed.

ON SOME POINTS OF PRACTICE IN IRON FOUNDING.

No. XVI.

In our last paper we treated of the effects of greater or less fluid pressure upon the molecular arrangement of cast iron in castings, in modifying the density of the metal, and the development as to size, of its integrant crystals, and through these affecting the ultimate passive strength of the casting itself when made and cold. We are now about to consider the effects upon the molecular arrangement of the metal, of difference of *form*, and of mere increase or decrease of bulk in the casting, and of the relation between bulk and superficies in the same.

These conditions are very far from being mere theoretical speculations, interesting in the laboratory of the scientific metallurgist. When

once thoroughly understood they afford guiding principles of the highest value, and of continual use to the engineer or mechanician who designs the sizes and forms, and to the iron founder who is to produce these, for any and every use in cast iron. But like every other class of systematized truths resting upon fundamental principles, and not familiarized by constant appeal to the eye or other senses, *unless they be thoroughly understood*, they are as likely to prove a misleading "will-o'-the wisp" to those who thus walk in darkness; of this we shall have occasion to present an instance hereafter. First, then, as regards the effects of *form only*. It is a *law of the molecular aggregation of all crystalline solids, that when their particles consolidate (from a liquid or pasty condition) under the influence of heat in motion* (i.e., *here, of cooling*), *their crystals arrange and group themselves with their principal axes in lines perpendicular to the cooling surfaces, of contour of the solid; that is, in the lines of direction of the heat wave in motion, which, as respects the internal constraining forces produced by contraction of the cooling body, is in the direction of least pressure within the mass.*

This is true, not only in the case of a body consolidating from fusion, but true also in a solid heated *ab extra* sufficiently to admit of its crystallization, if not already crystallized, but being a crystalloid body, *i.e.*, one capable of assuming the crystalline condition; it is equally true whether the wave of heat pass outward as by cooling, or inward as by heating the exterior *couche* of the solid.

For proof of this law, and for instances of its generality, we can here only refer the physical reader to the original memoir where it was first developed, by Mr. Mallet, in the Transactions of the Royal Irish Academy for 1855, and for some confirmatory instances, to the memoir by the earl of Rosse, upon the casting of his great telescopic specula, in the Philosophical Transactions for 1861 (Vol. 151, Part 3, p. 689). Here it is our business to deal only with that particular case of it which applies to cast iron, which we need not repeat is a crystalloid body.

When, therefore, a casting in iron passes, after being poured, from the liquid to the solid state, the principal axes of its integrant crystals, that is, the longest axes of symmetry of its crystals, are always found to *tend* to arrange themselves in lines perpendicular to the bounding planes of the mass; or, what is the same thing, the cleavage or dividing planes parallel to those axes are found to have grouped themselves normally to the external contour of the casting. The fact is more or less familiar to every iron founder. We say *tend* to so arrange themselves, because, except in some not common cases, with the ordinary makes of pig iron of commerce, and in those of cast iron rich in manganese, or in silicon, or in both, the development of size in crystal is almost always so small, as more or less to mask the phenomena. In the manganesiferous irons (spiegel eisen), on the other hand, the phenomena are strikingly distinct; great planes of crystalline cleavage are seen to pass through the mass when fractured, whose directions are always approximately perpendicular to the contours or bounding planes of the same. So also cast irons which are very rich in uncombined carbon, in the state of graphite, as in the case of the very dark-coloured No. 1 Scottish pig irons, the planes of cleavage (often coincident with the plates of graphite) are very distinctly seen, but the arrangement is generally ill defined, arising from very unequal and irregular cooling.

The development of crystal in castings of iron thus depends—

(1.) Upon the chemical character of the cast iron itself as above alluded to; and upon which much more might be said were we to pursue the subject here exhaustively.

(2.) Upon the absolute mass of the casting; the largest castings presenting for any given "make" or variety of cast iron the largest and coarsest aggregation of crystals, but by no means necessarily also the most regular arrangement of these, which depends chiefly upon

(3.) The rate at which the mass of the casting has cooled, and the regularity with which heat has been carried off, by *conduction* from its surfaces to those of the mould adjacent to them; or by *evection*, by currents of air aided by *radiation*, in the cases in which the casting has been "stripped," and let to cool out of the mould, or in free air.

So that always bearing in mind that chemical constitution determines in any given make of cast iron *the tendency to develop* crystal; the *regularity of development* of the crystals depends upon the regularity with which the mass cools, or with which the wave of heat is transmitted from its centre of figure to its surface during the whole period of cooling; and the *extent of development*, or, what is the same thing, the size of each individual crystal depends upon the time during which the process of arrangement is going on—that is, *upon the length of time that the casting of a given make of iron takes to cool.*

It is obvious, therefore, that the temperature at which a casting is "poured" influences (all other things being the same) the "coarseness of grain," as workmen say—*i.e.*, the development of crystal; for the higher the temperature may be of the fluid iron, above that just necessary to its fusion, the more heat there is to be given off, and therefore the longer the fluid mass requires to cool down and reassume the solid state. Indeed this superabundant heat influences the *development* of crystals and also their *arrangement*, because, as the metal is poured hotter, so is the total amount of contraction between that temperature and final cooling greater; and upon the internal strains, parallel to the surfaces of contour, depend, as we have seen, the directions given to the principal axes of the crystals (which are arranged at right angles to such strains): the constraining forces determining this arrangement being thus greater through a longer range of temperature, so is their resulting action more decisively marked.

The most *regular* possible arrangement of crystalline axes is produced by "chilling" or casting in an iron mould, the high conducting power of the sides of which enables it to carry off the heat with great rapidity (and hence in so far, and alone, in a way not favourable to development of crystals of large size); but the heat wave thus carried off by conductivity is very regularly transmitted outwards (with regular forms of casting and proper volume of chill mould), so that the regularity of arrangement is very perfect. It is not uncommon to see the principal axes of the crystals in a "chilled casting" for a depth of from 1½ inch to 2 inches penetrating into the substance of the casting, and all arranged with perfect symmetry parallel to each other, and perpendicular to the external surfaces of contour. Other circumstances occur, however, in the "chilling" of cast iron, as well as mere arrangement of crystalline axis, into which we shall enter more fully when treating of that important form of moulding and casting. It is enough here to state that, by "chill casting," the chemical constitution of the cast iron is, to the depth to which the chilling extends, actually changed. Carbon in its *uncombined* form, viz., as graphite, is exuded, and the *combined carbon alone remains in the chilled portion* of the casting; the latter differing little from steel in chemical constitution. This is the effect of rapid cooling merely, the nature of the material of the mould, provided it be one capable of carrying off heat rapidly, being wholly indifferent. Constant effusion of water upon the surface of a casting, and the generation of steam rapidly in large volumes, or even a rapid and powerful current of cold air, will produce the principal phenomena of chilling, though less distinctly for obvious reasons than the cold walls of an iron mould.

Thus, therefore, it is that "skin" is formed on all green sand castings, and that this is harder and thicker, in proportion as the surface of the casting bears a larger ratio to the bulk of the casting; the conductivity and other cooling powers of the green sand mould being the same. Upon fracturing through very small or thin green sand castings, it will be found either that there is a white skin, a thin superficial *couche* of genuinely chilled iron all over the contour of the casting, or that if its volume be *very* small in proportion to its surface, it may be found chilled right through, though cast even in dry sand. This is the fact with the thin *bassi relievi* of medallion heads and the like, which are cast at Berlin in dry sand, and from soft gray iron. The castings are not more than $\frac{1}{16}$th of an inch thick; and they are white as silver all through; as hard as hardened steel nearly, and the fracture showing crystals, which, in so far as they are developed, are all perpendicular to the contours.

It results from this that every casting has a chilled surface of variable thickness, according to the relation between its volume and surface and to the way it has been cast; and as, so far as this chilled skin of greater or less thickness is concerned, the chemical constitution of the metal is actually changed in the act of its consolidation, so it follows that continually remelting and casting and cooling the same mass of cast iron must result in the more or less rapid alteration of the chemical constitution of the entire mass; and this although we shall assume that no metallurgic change whatever may have taken place in the metal in the furnace, or due to the action of the air or fuel, &c., in the repeated meltings. Upon this depends, in fact, the every-day employment of "scrap metal" to mix with pig or other softer metal in the cupola, in order to confer upon the latter greater hardness and a closer grain. The scrap metal has itself become more or less "chilled," and in part

converted into white cast iron every time it has been previously cooled from fusion, not to say anything as to what changes it may or may not have undergone by furnace action in each of the fusing processes themselves; and so its mixture is in effect that of iron rich in combined and poor in uncombined carbon, with other iron (gray pig, &c.) having just the opposite properties, viz., rich in uncombined and poor in combined carbon, and the united whole is harder and denser than the latter is alone. But it by no means follows that the crystalline "grain" of the casting made from such a mixture shall be smaller or finer than that of the pig iron melted to make it, or even not a great deal coarser. For from what has been already stated as to the effect of bulk and time of cooling, it is plain that the *size of the casting* itself, other conditions being the same, determines the coarseness or fineness of the grain, which is only a workman's phrase for the development of crystals. And thus the fallacy of the stereotyped phrase in civil engineers' specifications, which so commonly prescribe for large castings that they shall be made with a certain proportion of "small *close-grained* scrap metal" mixed with the pig iron, is apparent. The notion is that *close-grained small scrap* will necessarily produce a *close-grained large casting*. As well might small seeds be sown to produce small trees. The small scrap, when cast and slowly cooled in the great casting, again becomes large and crystalline in grain.

Misconception as to these various conditions always in play in the consolidation of every casting, has given rise to the very mistaken conclusions promulgated by Mr. Fairbairn (Reports British Association for 1853) as to the supposed improvement effected in the physical qualities of cast iron by repeated meltings and castings. Erroneous and capable of very much misleading the merely practical man as these conclusions are, they have nevertheless been reprinted by their author at a comparatively recent date, and have been tacitly accepted and quoted from, in popular works on metallurgy as though perfectly well founded, and that although their inconclusiveness has been demonstrated in type more than once. Mr. Fairbairn concludes from his experiments, that by remelting the same cast iron and casting it into 1-inch square bars, the grain of the metal and the physical qualities of the castings improve by *some function of the number of meltings;* and he fixes upon the thirteenth melting as that of the maximum strength of the casting. This was, no doubt, the fact as respects the *particular* cast iron he employed, melted in the way he melted it, cast in the way he cast it, and made into castings of the size and form he made, viz., inch-square bars; but it can only be true for the particular case, and would cease to be true were any one of these conditions varied. The result of these experiments is not applicable to castings (everything else remaining the same) of any scantling greater or less than that tried, viz., 1 inch square. If from a given mixture of metal, or a given pig iron, the thirteenth melting and casting gives the maximum strength in bars of an inch square, it does not follow that this would be so for bars of 2 inches square, much less for masses of 2 feet square. Upon small bars of 1 inch square, even a little more or less wetness in the greensand mould would vary the rate of progress towards maximum strength in an important degree. With masses of a foot square the grain of the iron might be very much the same after the thirteenth, or even the thirtieth melting and casting, as at first, though its chemical constitution *might* have been changed in furnace, and in all probability would have been materially *deteriorated*, in place of being improved, long before the last number had been reached. In fact, Mr. Fairbairn's *general* conclusion is too large, and not logically warranted by the premises, if the whole of these be rightly understood and taken into account; and, as a practical maxim, the notion that the thirteenth melting of cast iron gives the maximum strength to all castings made from it, no matter what these may be in form or size or method of casting, it is simply absurd, and if relied upon by the ignorant moulder, likely to produce serious mistakes and failures in practice.

Indeed, if we attempt any general maxim at all as to the effects of repeated meltings, it must be this, that so far as the melting alone is concerned, every time the iron is liquefied in contact with flux and fuel and air, it takes up an additional dose of the metallic bases of the alkalies and earths, and of oxides and siliciurets, and probably of even other foreign matters, so that, so far as melting alone is concerned, every time the iron is fused it is, in a manufacturing sense, a worse in place of a better material; and that, so far as the cooling and consolidation *alone* are concerned, whether the iron shall when cold have a greater or a less passive resistance per unit of section (*i.e.*, increased, or the same, or decreased strength), must depend upon the other conditions which we have indicated in this paper, but mainly upon absolute bulk, and upon the relation of bulk to surface in the castings made.

We have avoided saying anything here as to the important effects produced by external form, and more particularly by abrupt changes of form, and by the connection of bulky with attenuated parts in the same castings, in this paper. It has been conclusively shown by Mr. Mallet, that, as one of the consequences of the law of crystalline arrangement pointed out by him, all such changes as above, are attended by the production of *planes of weakness* within the mass of the casting. These conditions, however (though highly important to the civil or mechanical engineer or mechanician, who by his designs has to determine the forms he shall assign to every given piece in which he employs cast iron, either in structures or machines), have less immediate relation to the iron founder's own special science and art; his business being to make a sound casting, or one as sound as possible, of whatever form and size he is directed to do. At the same time, it is not wholly unimportant that an iron founder should be able upon principle to point out if a design or pattern for a casting be such that it must inevitably prove unsound, defective, or weak in certain directions, and to state why so.

From what has preceded, at the commencement of this paper, it is obvious that the specific gravity of every casting must vary, not only as pointed out in the last paper (No. XV.), with the *fluid head* or pressure under which it is cast, but with its *bulk*, and with the relation between *bulk* and *superficies*. The only experiments, we believe, that have ever been made to determine what these differences of specific gravity within a given range may numerically amount to, have been made by Mr. Mallet, and are condensed in the following table. Parallelopipeds of cast iron, all of 5 inches square, but varying in thickness, viz., ¼ inch, ½ inch, 1 inch, 2 inches, and 4 inches thick, were cast at the same running and in the same greensand mould. Pieces were then cut from each, free from actual skin, but adjacent to the surface in the whole, and the specific gravities determined. Similar experiments were made for the same three makes of cast iron, viz., Calder No. 1, Blaenavon No. 1, and Apedale No. 2, experimented on with respect to head or fluid pressure (paper No. XV.), and with the results given in table on next page. The relations between bulk and surface are as follows:—

	Size. Inches.	Volume. Cubic Inches.	Surface. Square Inches.	Ratio.
A	5 × 5 × 0·25	6·25	55	$\frac{55}{6\,25}$
B	5 × 5 × 0·50	12·50	60	$\frac{60}{12\,50}$
C	5 × 5 × 1·00	25·00	70	$\frac{70}{25\,00}$
D	5 × 5 × 2·00	50·00	90	$\frac{90}{50\,00}$
E	5 × 5 × 4·00	100·00	130	$\frac{130}{100\,00}$

The results point distinctly to a decrease of specific gravity due to mere increase of bulk; which is to say, in other words, that with precisely the same quality or make of cast iron, and, indeed, all other conditions except size of casting alike, the larger casting is relatively weaker than the smaller one. We do not double the strength of a simple flitch girder, for example, by merely doubling its thickness—a conclusion to which Mr. Edwin Clark also has arrived in his account of the Britannia Bridge. Mr. Clark refers for his data to the experiments of Captain, now Sir, Henry James, R.E., made in relation to the Commission on Railway Structures of Iron. That gentleman ascertained the ultimate resistance to transverse strain of a number of bars of cast iron, of very different scantlings, but similar in form; and found that, as the bars became larger, "the spongy crystalline texture of the central portion modifies the strength very considerably," and also ascertained that "bars planed from the central portion of larger bars are comparatively very weak"—*i.e.*, weak as compared with equal sections from the outer portions of the same large bar. "Hence," says Mr. Clark, correctly, "the strength of *large* beams cannot be computed from the constants given by experimenters, and derived generally from bars of 1 inch square in section." But neither Sir H. James nor Mr. Clarke evince the slightest appreciation of the true principles upon which those differences rest; and they both confound the decrement of strength due to mere "sponginess," *i.e.*, to hollowness produced by "draws" in final contraction and consolidation at the centre of a large bar (which is, in fact, the same thing as diminished section, or as the difference between the real and the apparent section in the small bar planed out of the middle of the larger one), with those differences of which we have indicated the causes above, and which are perfectly irrespective of any

hollowness, or "sponginess," or defect in the metal, and due solely to certain inalterable conditions of molecular aggregation in cast iron.

Nor does Mr. Clark show that he has any clear notions on the subject of the real effects of repeated meltings and castings of cast iron when he says—"The advantages of running metal over again for large castings, which is commonly the practice with founders, was also clearly shown," *i.e.*, by Captain James.

We are not aware that any such practice exists; it certainly is not common. We have shown what the effects are, and upon what they depend. (See Clark's "Britannia Bridge," vol. i., p. 443.)

Mark of Experiment.	Calder, No. 1. Hot Blast.			Blaenavon, No. 1. Cold Blast.			Apedale, No. 2. Hot Blast.		
	Dimensions of Casting.	Specific Gravity.	First Difference.	Dimensions of Casting.	Specific Gravity.	First Difference.	Dimensions of Casting.	Specific Gravity.	First Difference.
	Inches.			Inches.			Inches.		
A	5 × 5 × 0·25	7·0560		5 × 5 × 0·25	7·1449		5×5×0·25	7·1876	
			·0299			·0015			·0141
B	5 × 5 × 0·50	7·0261		5 × 5 × 0·50	7·1464		5×5×0·50	7·1735	
			0366			·0041			·0571
C	5 × 5 × 1·	7·0627		5 × 5 × 1·	7.1423		5×5×1·	7·1164	
			·0771			·0270			·0358
D	5 × 5 × 2·	6·9856		5 × 5 × 2·	7·1153		5×5×2·	7·0806	
			·0268			·0211			·0323
E	5 × 5 × 4·	6·9588		5 × 5 × 4·	7·0942		5×5×4·	7·0433	

In a future paper we shall treat more completely of the subject of chill casting, and in connection with that shall probably recur to the subject of planes of crystalline weakness in castings, which we have here but barely touched upon.—Ed.

HOW TO MAKE SAFES SAFE.

There is a prodigious amount of humbug in the "Safe trade." At least half a dozen great safe-makers are in type, *in perpetuo*, in the shape of advertisements, each claiming to be in fact the only one that can produce *a safe safe*; and several either directly or by implication declaring that no other safe, except each their own, is worthy of the smallest trust, or the maker of credence. It is very much the quack medicine vendors over again, "To buyers—carefully remark our signature upon the label of each bottle, without which none are genuine;" "Beware of spurious imitations," &c., &c.

Not many months ago we were favoured with a pretty bulky octavo pamphlet, headed, like the quack doctors again, in some such style as this: "Five thousand safes burglariously broken open in the last three years—the cases in court—the great trial of Jowler *v.* Cheeky, with remarks," &c., &c., &c.; the whole leading up within the last twenty pages to an elaborate encomium and advertisement of certain patent safes, with price lists and so forth duly appended; and that the likeness may not be lacking in any respect, as the quack doctors give their illustrations of "cases" showing the frightful effects of *not* taking Doctor Diddler's Elixir of Rejuvenescence, so we have here elaborately set forth in woodcuts, in half a dozen different places, all the actual or assumed dreadful kit of tools of the "burglar and safe-breaker." All this is very contemptible and very ridiculous. The trade of making "safes" is *per se* an honest and respectable one; advertising is recognized as a suitable and legitimate mode of increasing business, and we know of nothing dishonourable in its employment, so as it be honestly employed. But it is not so employed in our judgment, when the basis for the extension of this business is made to depend upon—first, the endeavour to persuade the public (*i.e.*, the comparatively and technically ignorant) that it is scarce possible, if possible at all, to guard against the superhuman devices and limitless ability and resources of the British burglar; secondly, that nobody has ever yet succeeded in doing so except the advertiser, in the interior of whose patent safes it is well known (as proved by public exhibition) a thirteen-inch shell may be exploded with perfect immunity from injury, while it is equally ascertained that fifteen minutes, a drill and brace, and half an ounce of powder, are enough to do for Mr. Muff's (the rival's) safes. All this is in the thief-resisting direction. In another, but uncommonly like category, we have the "fire resisters," of which public *autos da fé* are made in vain, and between the inner and outer linings of which, in "refrigerant fluids," is contained the quintessence of ten fire-brigades. We shall not meddle with the safe in its salamander capacity at present, however; but as respects safes intended to preserve valuables against robbery we venture to make some remarks.

And first, as resulting from all the information that we have been able to gather of a trustworthy character, upon the subject of the vast abilities of the British burglar in the way of original invention and mechanical resource, we are disposed to think he has been overrated. However natural and even graceful it may be on the part of his natural enemy, the safe-maker, not to hold a low opinion of a vanquished, or to be vanquished foe, we are much mistaken if in the impartial judgment of those who best know Jim Sykes, such as detectives, police magistrates, gaol warders, Old Bailey lawyers, and even his own "pals," his abilities in these directions are not quite on the level of his social position. Masterly ingenuity and contrivance finds other and better employment than in house or safe breaking, and is as a rule accompanied by something better in the way of natural moral developments, than to find itself in the felon's dock, unless perhaps once or so in ten thousand cases.

A Furze, a Barrington, or a Macaire, may once in a century present the terrible anomaly of great ingenuity united with reckless daring and an unscrupulous acquisitiveness; but in the great run of the shoal of vulgar burglars, though we admit the prevalence of a largely developed cunning, the *vulpine intellect* of Carlyle, its accompanying ruffianism is not relieved or tempered by great forecast, by the *knowledge* without which great mechanical skill, to whatsoever applied, is impossible, nor by natural inventive power of an even average character. The means and methods of the burglar are in fact nearly all, if not wholly, borrowed; they have been picked up from the pothouse talk often of skilled workmen, met with casually, and probably who have had no idea by whom and for what ends they were drawn into conversation; now and again got from the misdirected skill of some skilled workman that had unhappily lost his honest way through the world; and if the fabulous be sifted out, they resolve themselves, as respects iron safe-breaking, into a few very obvious and rather crude expedients, and the tools or means to carry these out. We say thus the fabulous being removed, for in that class we hesitate not to place a great deal of what has been affirmed as to things said either to have been done, or that are ready to be done any day in iron safe-breaking. Blowing the doors of double-cased safes to pieces (*so as to be able afterwards to open them*) by gunpowder or other explosives, is in the *semi*-mythical region. It may have been done with sham safes made simply to sell, and the inner plates of which might probably have been struck off by a steel punch through the key-hole, in half a dozen blows from a sledge hammer; but with any honestly constructed safe it is all but impossible, and for the very simple reason that there is too much space, and therefore want of fulcrum, except for a very large quantity of powder to act, and that a very large quantity the burglar dreads for many reasons to fire. Besides which, it must be by a coincidence of accidents amounting almost to the miraculous, that the door of a safe, after it may have been distorted by the explosion of powder between the outer and inner plates, shall be *so distorted* that the bolts in place of having been freed or broken out of hold, shall not have became so bent, entangled, and engaged, as to make the subsequent opening of the door, even by violence, impossible within the burglar's means. Grant unlimited powder—common gunpowder, to say nothing of fulminates; let it be assumed that the burglar is at liberty to declare *open* warfare, and "sit down before the place" without fear of result as to his method, or of any interruption that may suddenly oblige him to "raise the siege," or find himself the captive of "the relieving force"—and we admit that a common petard, nay, a mere canvas bag of powder if big enough, hung by a string and fired by a bit of Bickford's fuze, may be made to do the work of opening most safes that have been made. This, it is said, has actually been done at "the Diggings," where one set of desperadoes kept the garrison at bay, with revolvers at their heads, while the others blew the safe filled with gold to pieces, by a plentiful supply of powder laid against some one side of it; but in regions of law and of thick population all that is out of the question.

To the purely and absolutely fabulous, belongs a heap of the alleged methods and contrivances for meeting, by ingenuity, the difficulties that the ingenious safe-maker interposes by his modes of construction between the burglar and his prey. It was thus gravely and

circumstantially alleged not a great while ago in the public prints, by some writer who called himself an engineer, that hardened steel external plates to a safe offered no real obstruction to the burglar's drill; that with perfect facility he *softened the steel by the aid of the blow-pipe;* a mouth blow-pipe and a common candle was all he wanted, to soften at one point a part of a plate of steel of perhaps a hundredweight, whose mass would conduct away all the heat that could be thus raised so fast that the metal could thus probably never be got as hot as boiling water! Then this was improved by subsequent writers who saw the silliness of this nonsense, into a new form; the burglar carried with him a small furnace to burn coke, and a rotary fan to produce a blast, and he directed the flame from this apparatus against the place he wished to soften. We should like to see an actual example of this apparatus, known to have been taken red-handed from a safe-breaker. Until we shall have been so fortunate, we shall still doubt the utility (for the ultimate end in view) of the machinery, and the probability that any burglar would venture to employ it, even if he was stupid enough to believe in its usefulness to himself.

The same class of remark applies to divers so-called "burglar's tools" that we have seen circumstantially described and figured, in actual application to safes, some of which any really skilled and practical mechanic will at a glance see must prove utterly useless; others such as could not by possibility be carried without detection. Assume a perfect lock, as we have a right to do now when those such as the Adytic lock can be had, that are *impossible* to be picked; let it be granted that an iron safe cannot be opened by any tampering with the lock alone, and that if opened it must be by violence; then we believe the burglar's methods really resolve themselves into attempts to wedge open the edges of the door or doors more or less, and then to pinch open or off the door by one or more powerful steel nibbed crow-bars, or to force off the back plate and lock, or to tear off the door bodily (if he can provide the means to catch hold of it) by means of the small screw jack. We believe Mr. Sykes has not yet patronized Messrs. Tangye's hydraulic jacks, though there can be little doubt there is quite an unexplored region of wealth reserved for him in that direction. The attempt at any of these plans will be more or less perfectly successful, assuming the same conditions of opportunity and daring, &c., on the part of the burglars, in proportion as the safe itself is badly *constructed* and badly *posited*. Bad construction, while no doubt involving all the faults which the safe-makers attribute to each other, of bad workmanship and bad design, mainly consists (in those after all very simple products of the mechanical workshop), omitting the locks, in malconstruction of the door, both as to the nature of its rabbates, its pivots, and its bolts, and in a radical *deficiency in material* in every part of the safe. Only let there be iron enough in a safe, especially around the door, rabbates and bolt sockets, and door pivots, and with a good lock, an iron safe no more artificial otherwise in construction than an old mediæval iron chest may defy the burglar for hours.

But the *positing* of the safe in the premises where it is employed is quite as important, if it be not even more important, than the structure of the safe itself. This is a matter usually completely neglected; one as to which the advertisements and pamphlets of the patent safe-makers are for some mysterious reason almost or quite silent, and about which the public generally who employ safes appear to be in total ignorance. Only *place properly* within a building even a very common and otherwise vulnerable safe, and it may be rendered impregnable by the burglar.

It is upon this point that we wish at present more particularly to dwell. The methods of breaking open safes, as we have above limited them, involve *ex necessitate rei*, that in workman's language "a man shall be able readily *to get a blow at his work, and to get at it, and round it.*"

Wedging at all has been dreadfully interfered with in the later constructions of safes, by making the rabbates all round the door of a transverse section such, as to present nothing but short curved lines. When a thin steel wedge is got in or "entered," and attempted to be driven into such a rabbate, if soft it bends round the curved rabbate, and soon will go no further, but if hard it breaks up into short fragments and won't go in at all. But still, by the help of drilling and wedging together, even such safes may have a powerful dislocating force brought to bear upon them. Until this has in some shape been successful in opening the rabbate wide enough to get in the nibbed iron bar, nothing effectual can be done, *nor then*, if the safe itself be so posited that there is not radial room to force round the crow-bar, when applied as a lever. So that, in one word, *all* the operations of the safe-breaker resolve themselves (including all those of the screw jack) into such as demand indispensably two conditions if they are to be practised at all: 1st. That the position of the safe, or rather of the door side of it, shall be such that a blow with a hammer can be given easily, powerfully, and with uninterrupted certainty in direction, upon points round the extreme edges of the door. 2nd. That around the door side there shall be uninterrupted room enough for several men, or for at least one man, to bring his muscular efforts and weight to bear in forcing round a crow-bar of greater or less length, and the length of which, to be effectual, must be considerable.

Now we venture to affirm that if a safe be properly posited in brickwork, or best of all, in *hard stone* masonry, a very humble iron safe will (assuming the lock not pickable) prove absolutely impregnable, and such is the position which we purpose now to illustrate to some extent. Conversely we affirm that with the very best and most ponderous safes that can be made, the burglar is offered every chance, the field is left invitingly open to his success, posited as safes habitually are in innumerable instances. We could point out here some of the most important banks, some of the most opulent jewellers' and goldsmiths' shops, to say nothing of other wealthy establishments and private mansions, in which large and costly safes are brought in, deposited upon a timber floor, either with the back to a wall, often not in a recess, and even out some feet from any wall, and there employed as a receptacle for property, under the notion that a safe so posited is safe either against thieves or fire. It should become a maxim that no safe is safe (however ponderous or however made) unless it be imbedded in brickwork or masonry. We propose to show that, if such imbedding be judiciously done, the burglar's chances are gone. A few diagrams may best illustrate this. Fig. 1 is a horizontal section of an iron safe, as most commonly built

Fig. 1.

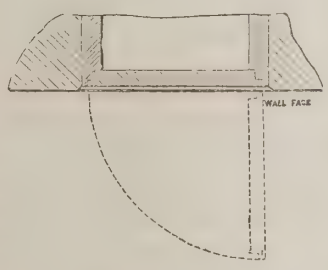
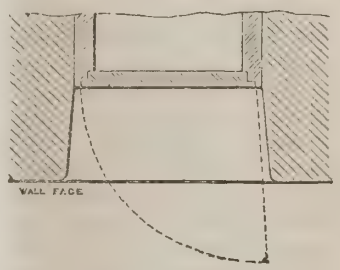


Fig. 2.

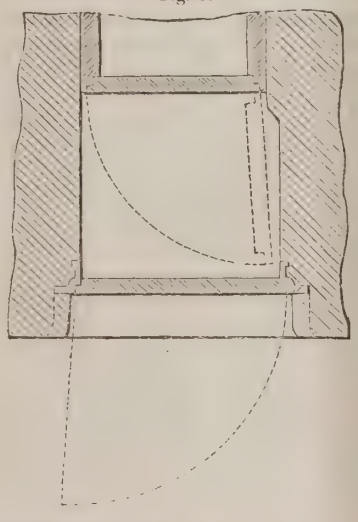


into masonry, when built in at all. The door of the safe is flush, or nearly flush, with the face of the wall. As regards wedging into the rabbates of the door, while it is no doubt true that the brickwork or masonry here, all round the rim of the door external to the safe, tends powerfully (if built up close) to support that against the effect of wedging, yet the whole perimeter of the door is freely exposed; it is perfectly easy to insert wedges (so far as position is concerned), and there is unimpeded room to get accurate and powerful blows at the heads of the wedges, free room to pick out some brick or spaul away some stone to clear way for their action, and ample and uninterrupted space in front for three or four men together to get crow-bars to bear upon the door, if space for these to nip has been once secured. Now let us suppose the very same safe built into the masonry, as in fig. 2, the front door being kept back from the face of the wall by even only some 12 or 15 inches, and the jambs of the opening slightly splayed, or not. Any practical mechanic will at once recognize the difficulty and awkwardness now of the position of the rabbate of the door for inserting wedges, the greater difficulty of getting a fair blow at any one to drive it home, even if already entered, amounting almost to impracticability as respects the horizontal rabbates at the top and bottom of the door; he will further remark upon the great mass of brick or of stone work that must be now removed from around the safe, if this is to be freed from external grip so that the wedge shall act; and lastly, will discern that to get crow-bars to act effectually upon the door, supposing the space for "nip" secured, is practically impossible. Many cubic feet of brick or stone would have to be pulled down and the rubbish got out of the way, so as to have clear foothold, before two or more bars could be got to act at all.

But the same simple and obvious principle may be carried much further. Again let us take the same safe; but as in fig. 3, let it be

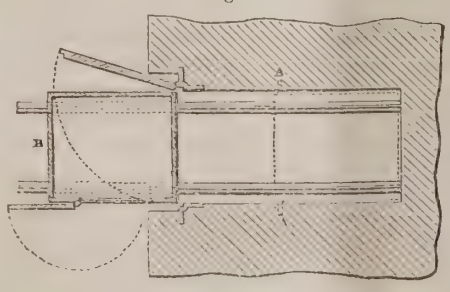
imbedded into a deep recess in the masonry, say from 3 to 4 feet back from the face of the wall, and let a second iron door and frame, in addition to and in front of that of the safe itself, be bedded and leaded all round into hard stone, and kept back, say, 10 to 12 inches from the outer face of the wall; and let us assume both doors strongly made, with curved rabbates closely fitting, and efficient locks, *i.e.*, not pickable. Now what is the burglar's position? He must go through all the tedious work of attempting to break open the outer door, before he can even see the safe door itself, upon which all his labour must be repeated with the immensely increased difficulties involved by its position at the rere end of a *cul de sac*, now bound with stone work all round, and with the only vulnerable parts of the safe door (the perimeter) so hemmed in that he cannot by any flexibility of limb or arm reach it with facility, and to get a fair blow at any thing near which is perfectly impossible. Should the safe be one of about 3 to 4 feet wide, and about as many high, it will be placed the most awkwardly possible for the burglar, by taking care that the outer door and passage between that and the safe shall be too low for a man to stand in even stooping, and that the *cills* of the safe and outer doors shall either be placed upon the floor level, or not less than 4½ feet above it; either position will insure about a maximum of awkwardness to his operations. The outer door should be so made that it can only open square to the face of the wall at the utmost; it will then, even if opened, be more or less an impediment to operations upon the door of the safe itself.

Fig. 3.



The protective powers of the surrounding masonry may be carried a great deal farther than shown in these diagrams, by a little care. Thus, for example, in fig. 6, to a larger scale is shown part of the side (or top or bottom) of a safe and of the door, with the curved rabbate, &c., and a portion of the surrounding stone-work, into which the safe is secured by a broad projecting lip of iron or steel all round the door rim, let into a rabbate cut into the stone-work, and leaded all round. The face of the stone-work should come *quite close* up to the rabbate of the door all round, allowing only just clearance to let the latter open. With such an arrangement it is obviously impossible to enter the rabbate by a wedge at all, and to remove the stone and lead sufficiently to admit of that and a subsequent blow, (equally so. In fact, safes might be classified in accordance with the way in which they are *posited* in the building, into hours for entry—three hour safes, six hour safes, twenty-four hour safes, &c., on to those that the burglar, with any tools that he can, and any methods that he dare command, cannot open in any number of hours, however great. In practice, a sixty hour safe would be really, in almost all cases in Europe at least, impregnable. But what we have as yet described, it may be said, has reference only to small or to moderate-sized safes—not that this is truly so, for it is obvious that the cubic contents of the safe itself may be as big as we like, even with the small doors of 3 feet or so, by 3 or 4 high, that we have proposed. But the same principles may be extended, and even much improved upon, in reference to the great-sized safes required by large establishments. For example, fig. 4 shows a construction of safe, or rather a mode of positing one, which we think, if properly executed, might defy a good deal more than the powers and ingenuity of Jim Sykes; would, in fact, defy the best efforts of an insurgent mob having "the run of the premises" for several days, and any amount of tools, short of jumpers and blasting, at their command.

Fig. 4.



The diagram here is also a horizontal section, but we expect will sufficiently render intelligible the plan, which, so far as our knowledge goes, is original, and has not been previously proposed by any one. A deep recess in granite, or other hard chisel-dressed ashlar work, is provided of the required size; the iron safe, which is best *not* double-cased, but simply of very strong plate iron (by strong *we* mean plates of from ¾ to 1 inch thickness) well put together, is in shape a cube or parallelopiped standing on end or edge, and is of such size that it can just be run in and out, as it stands, of the granite chamber. The door of the safe is (so to say) at one side, and is made when shut to be perfectly flush. Two grooved or flat rails are placed on the floor of the granite chamber, and as far outside it as may be necessary to enable the safe itself to be drawn out into the position shown in the diagram, and so remain during the daytime or when in use. In that position, as is evident, the door at the side can be opened and shut. When the safe is to be closed up the side door is shut and locked. The safe itself, with its contents, being mounted upon four low rollers, just projecting ¼ inch or so below its bottom, is then simply pushed back along the lines of rails to the extreme back of the granite chamber, where now, at five out of its six sides, it is within ¼ of an inch or so of the faces of the granite all round. At the end of the safe, B, and inside, is a lock which shoots eight or more large bolts from the safe into the granite (into iron-lined sockets leaded into that), in the direction, at the sides, of A A, fig. 4. The outer door of the granite chamber, which, on principles already stated, should be kept back 10 or 12 inches from the face of the wall, is now closed and locked. At the side, B, a tapped hole is provided to receive a ring bolt or hook for the purpose of drawing out the safe again, by the aid of a small pair of purchase blocks, or a small chain and windlass fixed to some suitable point opposite, in the direction of B in fig. But this tapped hole is in a piece of iron or steel, which, by the act of locking the bolts, A A, is moved away from the aperture in the plate of the safe,

Fig. 5.

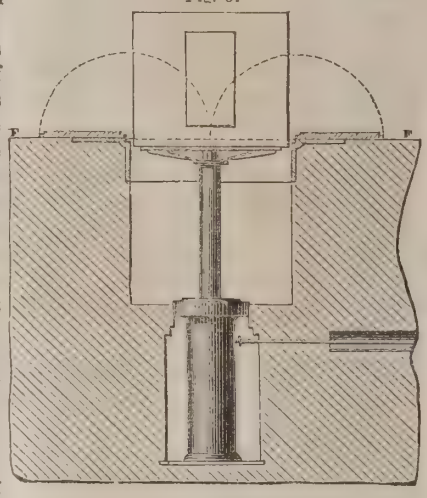


Fig. 6.

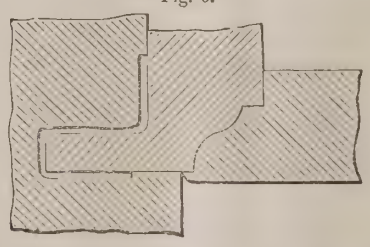
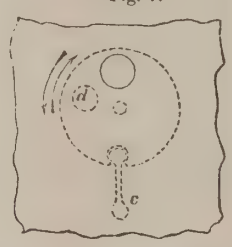


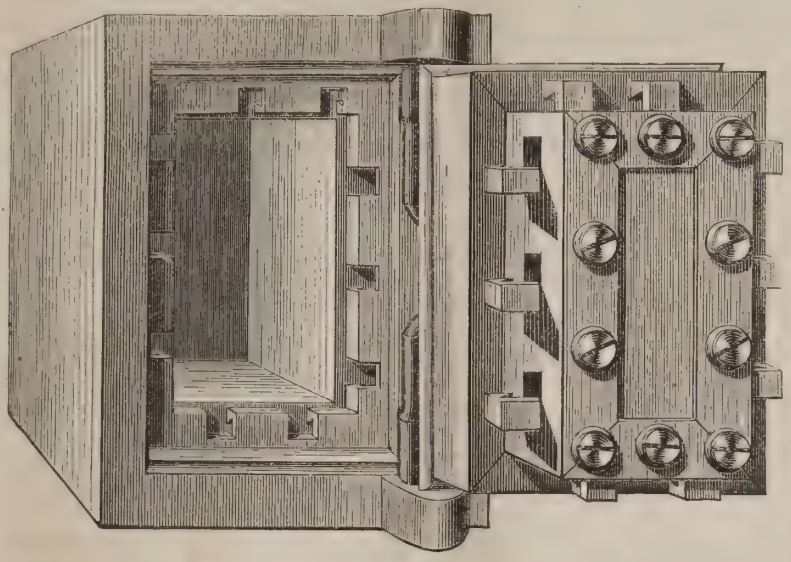
Fig. 7.



opposite to which it again comes back when the bolts, A A, are unlocked. This will be understood from fig. 7, where C is part of a lever from the lock to act upon the circular disc with the tapped hole, D, in it. As soon as the ring bolt is screwed out, the bolts, A A, can be shot from the lock; and, until these bolts are unlocked, the disc, C, does not come back into place, and, until it does so, there is no means of getting any hold whatever of the safe so as to draw it out of the granite chamber, even by an inch. Now what is the position of the burglar, or the mob even, in case of a great public disturbance and temporary cessation of the reign of law. First the outer door, with all the difficulties already referred to, must be forced; that done, next the eight or more bolts at the side, B, of the safe, which make this side just equivalent to another door, must be cut through or got rid of in some way, and under the most favourable view a hole of such size must be drilled into the plate as shall enable a

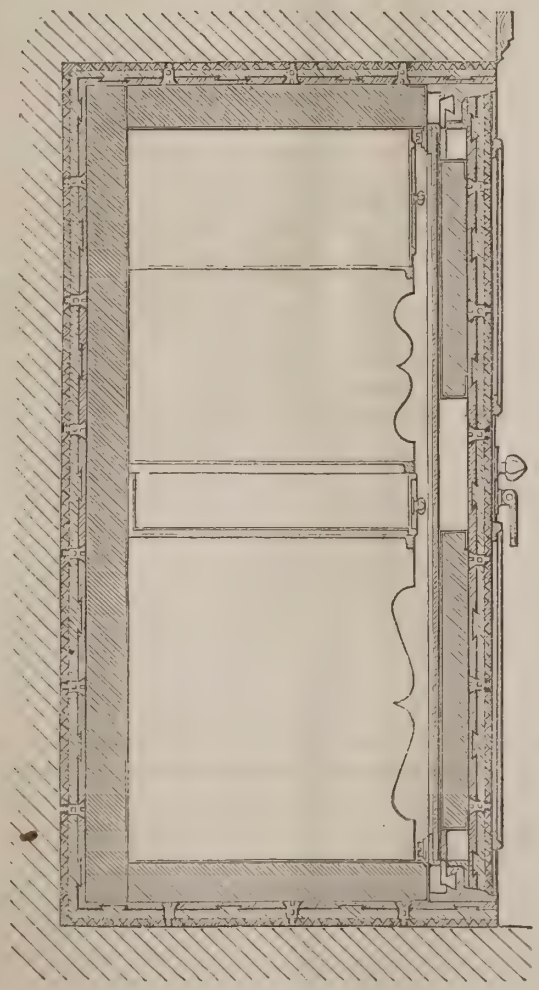
grasp to be got of the safe to pull it out of the granite chamber; but when it has been got out, the door of the safe itself has to be forced before the work is done, and this door, it will be seen, is so placed that

Fig. 8.



it is in a corner as it were between the front or door side of the safe and the face of the wall, at F, so that it is very awkwardly circumstanced

Fig. 9.



for wedging or forcing, or any other mechanical operation. Of course, many modifications of detail might be made upon the main idea of this kind of safe (and probably some such great efforts of ingenuity may enable some of the safe-makers to appropriate it more or less by the help of a patent); for example, the four rollers may be so connected with the locking apparatus at the side, B, that they may, as soon as the safe is in place, rise up free and drop the safe upon its base upon the floor of the granite chamber, resting with its full weight and friction, and until the bolts, A A, be regularly *unlocked*, it may be made impossible to raise the safe upon its rollers again; and divers devices may be conceived and employed for moving it in and out with facility, and fixing it irremovably (except by the proper person) when once backed into place. All this we pass over here.

Fig. 5 shows another plan closely analogous to the preceding, but which is, we have some reason to think, not original; that, in fact, it in some modification or other has been actually employed, though we do not know where. The diagram is a vertical section, F F being the level of the basement floor (or of any other floor with only masonry beneath it) of the bank or other establishment. The safe is a large cube or parallelopiped, of plate iron, with the one door at one side. The whole safe is mounted upon the stem or cylinder of an hydraulic press, and so arranged that while the safe is in use (*i.e.*, during the day) it is kept up in the position seen in the figure, when it is all above the floor level and convenient for access. When to be closed up, the door at the side is locked, the water is let out of the hydraulic cylinder, and the whole safe descends into the square pit of granite masonry provided for it below the floor level, and which it fills within half an inch or so of clearance all round. The top of the safe sinks about 6 or 8 inches below the floor level, and then a pair of iron traps or doors, which when opened back lie flat on the floor, as shown, during the day, are closed and locked over it; the air space between, and the position at the floor level being in this case an effectual preservative against fire.

The hydraulic press pump should be placed in a small wall recess at a distance, and within an effective safe door. The lever for working the pump should be detachable, and carried away at night, or deposited in a third small safe. The socket for its attachment should be made of a form, &c., that will only admit of its own lever, so that the pump cannot be worked by any makeshift bar; and there would be no difficulty in so constructing the pump that one of the valves should be easily taken out and carried off by the person in trust with the keys, &c. A small masonry passage, at all ordinary times bricked strongly up or otherwise secured, should lead in under the safe and to the hydraulic cylinder, so as to give access (after some time) to workmen in case of derangement. However, the whole is so simple, and the parts of hydraulic presswork so thoroughly understood and well-made now, that no liability to derangement need, we think, be feared in this, which we deem the best of all forms of safe for large establishments; for it not only offers, if properly executed, almost absolute security against burglars or popular violence, but presents conditions the very best possible for immunity against the destructive effects of conflagration. The indispensable condition for its use, however, is that there shall be no empty or inhabited story between the floor of the bank or other chamber to which the safe appertains and the solid earth. In the want of the observance of this condition it is that half the safe robberies become possible, and that so often the so-called fire-proof safe is found after a conflagration to have been only a crucible for the carbonization of every document, or the fusion of every precious metal within it. The majority, even of jewellers and goldsmiths' safes, are placed upon a floor often of wood, perhaps with a beam or two of cast iron beneath, but with free access to fire and to thieves at top, bottom, and sides all round. A safe, to be safe, is simply a question of cost. If the rent, &c., of premises be so enormous that space cannot be afforded for imbedding the safe in masonry, then the risk must go against the saving; but let the owner not sleep sound under the notion that he has got a safe at all, in the only true sense of the word.

In our humble opinion, the law should compel every banker, at least, to provide a safe embracing the conditions that we have indicated, and indeed the same would apply to attorneys and agents, in whose premises are often deposited documents of irreplaceable and priceless value to their owners, which we have often shuddered to see consigned to piles of tin boxes in offices, in old houses as dry and combustible as match-wood. Even in private houses, where small safes of some 5 to 10 cubic feet capacity are in very common use, and where they almost always

stand loose upon a wood or other floor, the owners would enormously add to their safety by building them into the walls in some convenient place, observing the conditions for hampering the efforts of the burglar that we have in the preceding columns pointed out.

Where circumstances are such that a safe cannot be other than loose or detached, then the main considerations as respects the safe itself are the following :—

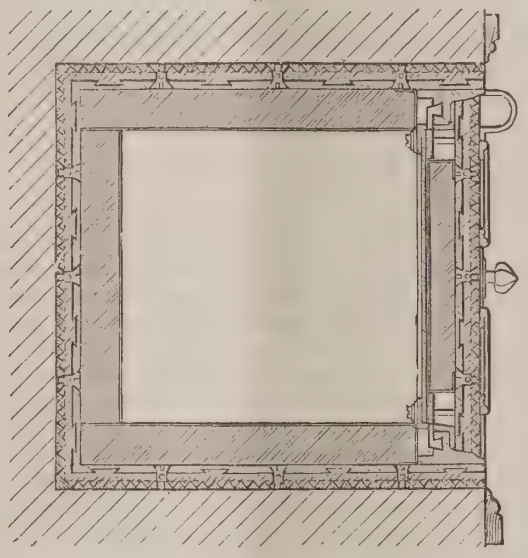
1. Let the lock be an unpickable one; for ourselves, we prefer Mr. Fenby's Adytic to all others, but there are other very good locks, *i.e.*, *very hard* to pick.

2. Pay enough to enable the safe to be abundantly thick in its shell, and the door thoroughly well fitted; weigh it, and divide the weight by the super feet of surface, is the only way to be sure of the scantling, and not even then, if it be one of the double-cased affairs filled up between with divers nostrums, probably resolvable chiefly into sand or brick dust were they visible.

3. By no means choose a safe with double doors (*i.e.*, two leaves locking at a joint along the middle, as shown in horizontal section, fig. 9). These are extremely deficient in resistance as compared with a single-leaved door, as shown at fig. 10.

4. Let the safe be one of those, of which we believe there are several makers now, in which the bolts are so arranged that when locked they not only shoot and so secure the door close, but in which they move also

Fig. 10.



sideways, and are made so as to *hook themselves* on to the jambs or rim of the door side of the safe casing, as in fig. 8, which is one of Mr. Chatwood's patent safes, where the mode of hooked-locking is pretty obvious.

This hooking arrangement is the best partial substitute that we are acquainted with for the external support against wedging afforded by bedding into masonry. But let it not be imagined that, however made, a loose safe can ever be safe. Putting aside all ingenuity and all other contrivances, a loose safe, unless it were of plates of a thickness never employed nor likely to be, can be broken into (especially if of small size so that a vertical blow can be got at it) by merely hammering at it by a heavy narrow-paned sledge hammer in the hands of a powerful man.

The fear of noise is in many circumstances no safeguard, and some of the most absurd fables that have been propagated about burglars' supposed tricks, are the methods by which is has been said they drive wedges with powerful blows without making any noise.—Ed.

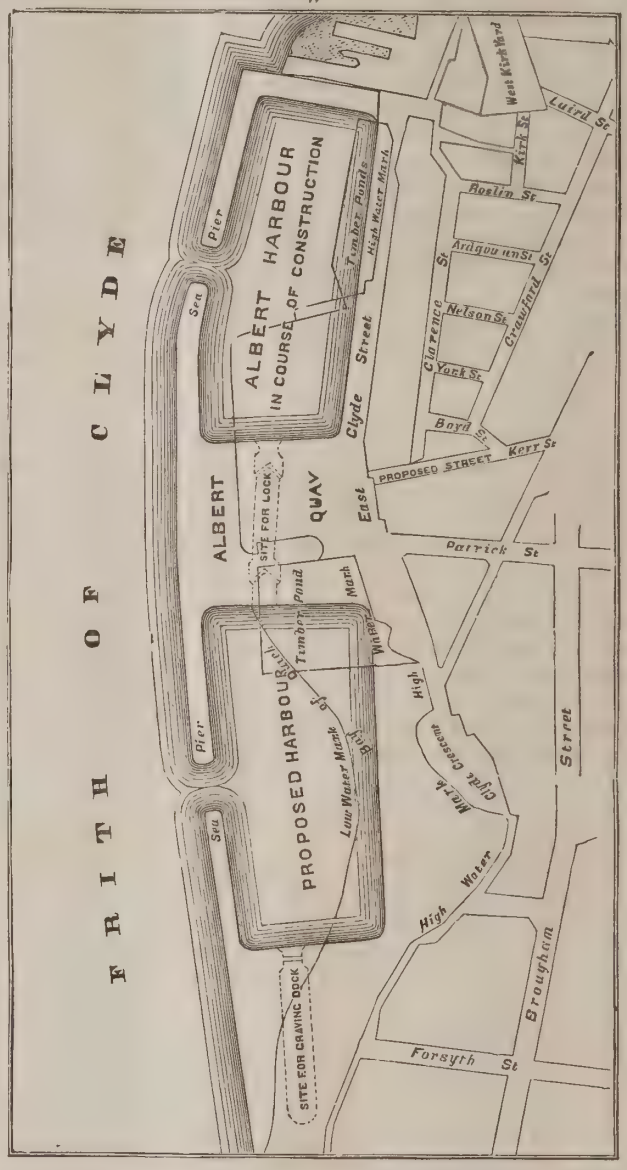
THE NEW ALBERT HARBOUR WORKS, GREENOCK.

These works, which when completed will supply a long-needed want of increased shipping accommodation to the Clyde, are now progressed so far that on Wednesday, 27th March, the first vessel entered the harbour; that vessel being the schooner *Northumbrian*, laden with stones to enable the contractor to proceed with some of the interior work. The foundation-stone was laid August 7th, 1862, by Mr. J. J. Grieve, Provost of Greenock, so that up to the present time the works have been in progress rather over four years.

As these works have been carried out in a manner altogether novel, and appear to us to indicate a generally cheaper mode of enabling the prosecution of many cognate operations *under certain conditions* (for we speak guardedly) hereafter treated, we feel thoroughly warranted in entering into the matter at length for the benefit of our readers, as we believe that little is known abroad respecting what has been done at Greenock, except what may have been gathered from the paper of one of the engineers (Mr. Daniel Miller, of Messrs. Bell & Miller, C.E.), some time since read before the Institution at 25 Great George Street, Westminster; access to which, however, is of course almost limited to those of the profession only who are members and associates of that community.

Previous to the new harbour, the accommodation at Greenock for

Fig. 1.



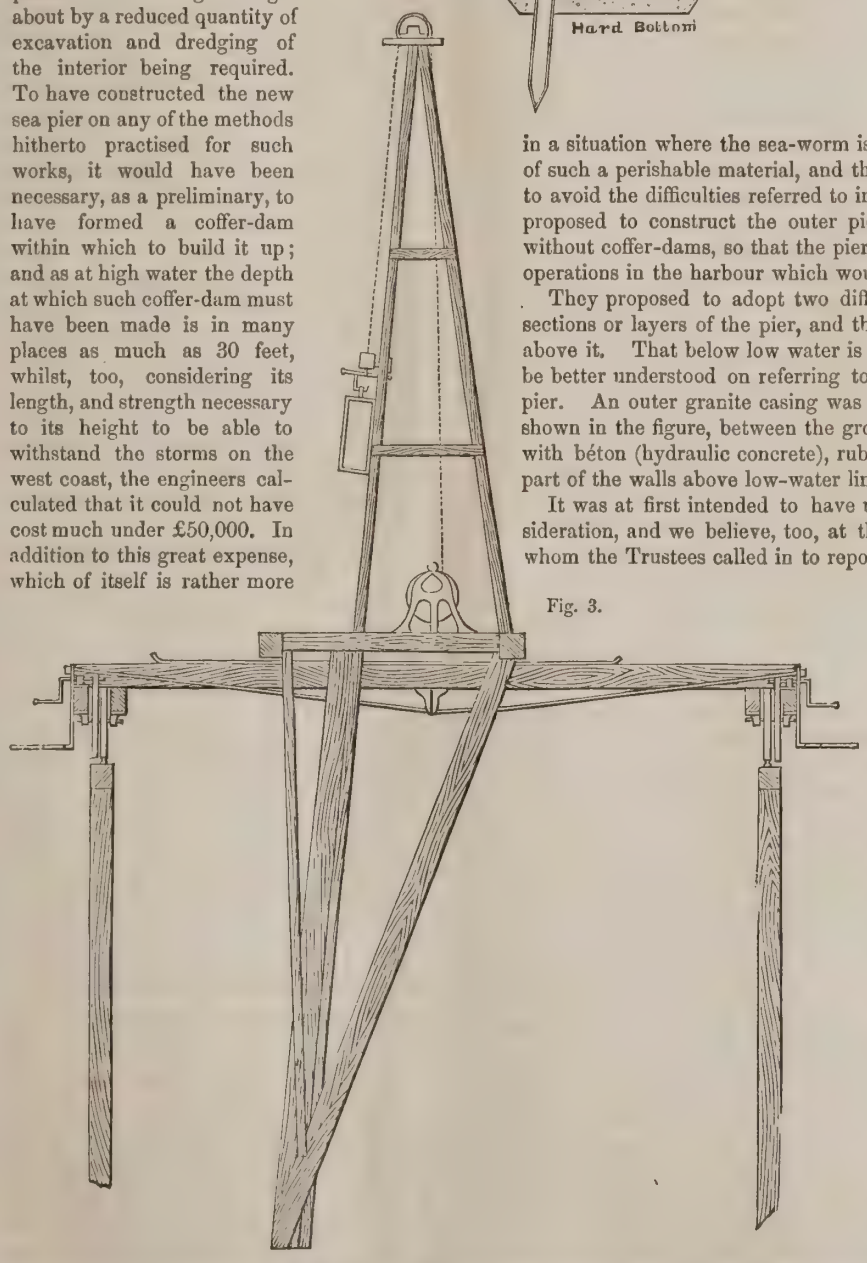
PLAN OF THE NEW ALBERT HARBOURS GREENOCK

the loading and unloading of vessels consisted of three open tidal docks, the most recently formed of which was under the direction of the late Joseph Locke, C.E., M.P.; and since the completion of the latter the demand for increased room had been so much experienced that various plans for dock or harbour extension were proposed. Comprehensive schemes for wet docks have been put forward at different times by several engineers, particularly by Rennie, Telford, and Walker & Burges; but hitherto no wet docks have been constructed, as it was considered the moderate range of the tide, from 8 feet to 10 feet, did not render them necessary, and the trade was found to be efficiently worked by the system in use. In the additional accommodation in progress the

pre-existing system of harbours is adhered to, though provision is left for conversion into wet docks, by the addition of locks and gates, should this at some future period be deemed advisable. The annexed woodcut, fig. 1, is a plan of the new harbour in course of construction, as well as the proposed additional harbour still further to the west.

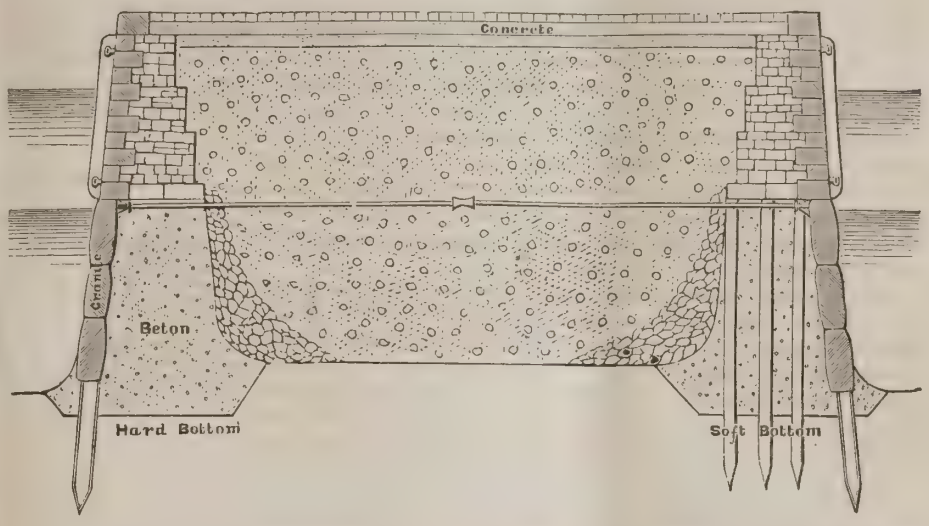
On account of the land in the vicinity of Greenock being of considerable value, it was determined to project the works into the sea as far as possible, without interrupting the deep-water channel, thus saving the cost of acquiring land, which otherwise must have been necessary. Still, on the side of cost, we must not leave out of regard the great additional expense of the sea piers of an advanced work like that under notice, founded in a depth of water thereby so much increased, as well as the greater length of approaches also necessitated; whilst on the *contra* side there must be placed the saving brought about by a reduced quantity of excavation and dredging of the interior being required. To have constructed the new sea pier on any of the methods hitherto practised for such works, it would have been necessary, as a preliminary, to have formed a coffer-dam within which to build it up; and as at high water the depth at which such coffer-dam must have been made is in many places as much as 30 feet, whilst, too, considering its length, and strength necessary to its height to be able to withstand the storms on the west coast, the engineers calculated that it could not have cost much under £50,000. In addition to this great expense, which of itself is rather more than a fifth of what the entire cost of the new harbour, sea wall and esplanade, land, &c., were estimated for, it would have occupied so much room in the deep-water channel as to have formed a serious hindrance to the traffic.

Fig. 3.



The Harbour Trustees, desirous, from motives of economy, to avert these difficulties, determined to erect timber outer piers; but, as Mr. Miller has expressed it, "it was the opinion of himself and partner that in a situation where the sea-worm is very destructive the work ought not to be constructed of such a perishable material, and that it was quite possible to built a solid structure so as to avoid the difficulties referred to in an economical manner. In order to effect this, they proposed to construct the outer pier and quays forming the seaward side of the dock without coffer-dams, so that the pier might of itself serve as a coffer-dam for the interior operations in the harbour which would afterwards be required."

Fig. 2.



They proposed to adopt two different systems of construction for different horizontal sections or layers of the pier, and they divided it into the part under low water, and that above it. That below low water is carried out on a combination of iron and stone, as will be better understood on referring to fig. 2, which is a transverse section of the outer sea pier. An outer granite casing was first formed, by sliding down the large granite blocks, shown in the figure, between the grooves in the piles, and afterwards filling in the back with béton (hydraulic concrete), rubble, &c., in the manner hereafter shown. The upper part of the walls above low-water line is carried up of good ashlar in the usual manner.

It was at first intended to have used freestone for the casing, but upon mature consideration, and we believe, too, at the suggestion of Mr. Thomas Page (M. Inst. C.E.), whom the Trustees called in to report upon Messrs. Bell & Miller's plans, granite from the Ross of Mull was substituted, which departure from the original proposals was unquestionably favourable to the permanence of the work; for whilst freestone may probably be very lasting when entirely submerged in still water, we incline to believe that exposed to the destructive and disintegrating attacks of sea storms it would not be found a durable material, although the effect of these may probably be diminished after the surface shall have become covered with the green pulp of sea growth that generally after a time envelops such submarine structures, the fibres of which would, it is natural to suppose, close up the surface pores belonging to that class of stone, whilst the elasticity of the marine envelope might tend to cushion the wave-blow away from the highly saturated, and partly loosened, surface.

In carrying out the works the first operation after the exact site of the pier had been fixed, was to dredge two parallel trenches down into the mud and soft sand which overlies the hard substratum, the red "till" of geologists, these trenches being for the formation therein of the wall foundations. A staging of timber piles was afterwards erected in the line of the pier over the whole breadth, for the purpose of carrying tramways, travelling cranes, pile engines, and all other necessary appliances. The staging being securely fixed, the next operation was to drive the guide piles, which are of cast iron and in section of a double T form, this part of the arrangements needing the nicest precision to enable the

casing stones to slide down and bed well upon each other and the concrete bottom.

For the purpose then of securing the necessary accuracy in bringing the guide piles into their requisite positions, a special kind of pile engine, fig. 3, was devised by Mr. William York, one of the contractors. The peculiar features in this pile engine are, that the guide beam is prolonged so as to extend downward to a considerable extent below water; it is, at the same time, erected at the same angle as that in which the piles are to be driven, and the lower member is firmly supported in position by a second backstay. The lower half of the guide beam constitutes the guide upon which the pile is laid previous to being driven; and since the monkey is guided so as to fall at identically the same angle, it is palpable enough that no appreciable error can take place by the piles being driven at a wrong inclination. It may, we believe, be with every fairness stated that these special pile engines have been largely instrumental to the success of the work.

The piles are 7 feet apart in the line of the face of each quay wall, and they were driven until their heads approached the low-water line. When in their places, they were coupled together at their upper ends by malleable-iron tie rods, through cotters let into sockets, cast on them. After the proper depth, namely, 17 feet below low-water level, had been dredged, it was found necessary to drive timber piles into the softer parts of the bottom, as shown at the right hand side of fig. 2, the hard bottom ("till") being exceedingly uneven, in some cases, indeed, as much as 20 feet below the bottom of the wall; that is, 37 feet below low water level. The reason for driving the timber piles being to provide a platform upon which to carry those parts of the superstructure above low water, where the ground was firm it was thought the timber piling would be unnecessary; we believe, however, that the engineers have not felt themselves warranted to dispense with it in any part of the works.

A length of the piling being driven, this was followed by depositing in the trenches a bed of hydraulic concrete, 3 feet thick, and the whole width of the trenches (20 feet), thus forming the base for the wall to spring from, and producing a large bearing surface.*

The granite casing stones were next let down into the grooves formed in the guide piles to receive their ends, their extremities resting on a transverse web cast on the piles, while the main part of the bottom is bedded into the concrete. Each slab or casing stone is from 18 inches to 2 feet thick, and, as will be seen on referring to figs. 2, 4, and 5, three only are used to fill up the space between any two piles up to low-water level. The face of the wall having been thus formed, some more hydraulic concrete was deposited behind it, in large boxes having trap bottoms, so that the contents could be discharged *en masse* at any point requisite; thus forming the body of the wall, and before it had time to set, loose rubble stones were carried up along with it, as shown at fig. 2, these confining it against the inner side of the casing. The filling in of concrete and rubble was then continued until the concrete reached low-water level; and the hearting, consisting of hard "till," stones, and gravel, was then thrown in, the whole being flushed off plain with the top of the casing stones and heads of the piles, thereby constituting a bed on which to raise the "above-water" section of the works. After sufficient time had been allowed for a complete consolidation and settlement of the immersed section of the works, the heads of the iron piles and granite casing stones were capped at low water level with a blocking or string course of granite, and the upper part of the walls carried up in freestone ashlar, and rubble; the remainder of the hearting was then filled in, and the whole finished with a granite coping and causeway. The walls are 33 feet high from the foundations, 11·5 feet thick at the concrete base, and they diminish to 5 feet thick at the top.

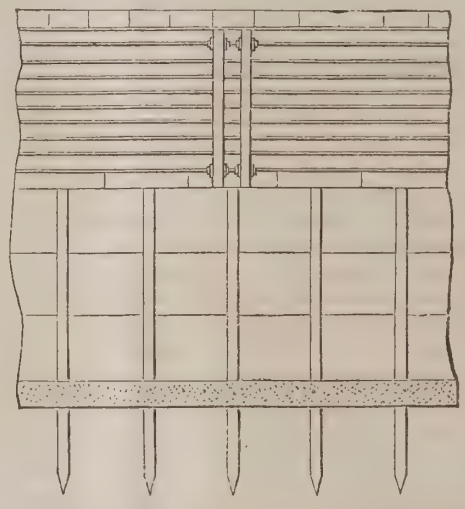
* The concrete employed was compounded of Arden hydraulic lime, iron-mine dust, sand, gravel, and stone chips; the lime and the mine dust being well ground under edge stone mills before being mixed with the other ingredients. The proportions were by measure—

Ground lime,	1 part.
Mine dust,	½ "
Sand,	1 "
Stone chips and gravel,	3 "

Immediately after being mixed, and when brought to a proper consistency with water, it was conveyed to the spot where it was to be used, then let down under water in discharging boxes, and in a short time was found to set very hard. The boxes used were either of iron or wood, and each contained 1 cubic yard. Those of iron were found preferable, as the buoyancy of the wooden ones rendered them somewhat unmanageable in a tide-way, after being emptied of the charge.

Whilst on this part of the subject it may be mentioned that the guide piling has been used in two different ways: at first, that more particularly shown at figs. 4 and 6, which are respectively a front elevation and plan of parts of the pier at low water, showing the ⊢ shaped guide pile therein adopted. This arrangement certainly is defective, in that the whole outer surface of one of the iron flanches is exposed to the oxidizing action of the sea; besides, too, it will have the effect in a short time of impregnating the granite with yellow oxide, which will destroy very much the otherwise good face of the work. In the latter part of the work, however, grooves are formed in the casing

Fig. 4.



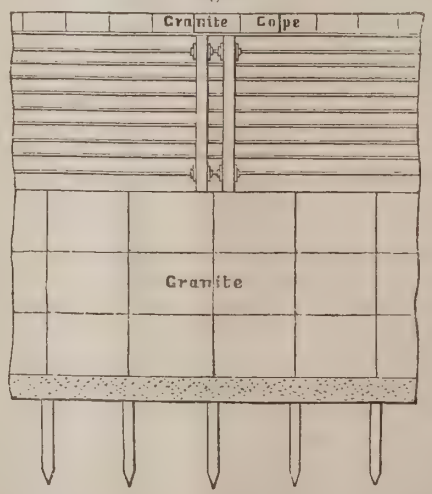
stones to fit over the outer flanches of the piles, as shown at figs. 5 and 7: a decidedly continuous facing is thus obtained, as no part of the iron piling is exposed. The grooves and joints are filled throughout with cement, completely protecting the iron flanches.

Now that the seaward pier is completed, the interior operations are being proceeded with, the pier serving one of its intended objects, namely, a coffer-dam substitute, to render which continuous, the entrance might be temporarily closed by a short coffer-dam.

The sea piers, 1200 feet long by 60 feet wide at top, were, we believe, contracted for at £63,000.

According to the original plan, fig. 1, the outer sea pier was to

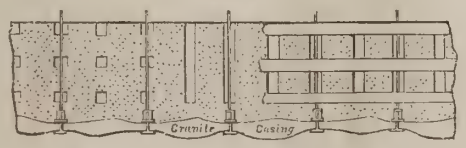
Fig. 5.



inclose a large extent of shore as well as the bay of Quick; and when carried to its full dimensions will be over 3000 feet in length. Within the area thus inclosed there is space for two harbours 1000 feet in length each; 15 feet deep at low, and 25 feet at high water, the entrances through the sea piers being 100 feet wide. The two harbours, when completed, will be connected together by a lock 350 feet long, the use of which, together with gates at the entrances, would enable one or both harbours to be converted into a wet dock, with a constant depth of 25 feet of water. At the west end of the proposed *second*

harbour is shown the site for a graving dock, which work the Clyde is now deeply in want of; although we think such a graving dock as present necessities of the shipping interests demand, should for very obvious reasons be constructed at Glasgow, rather than elsewhere on the river; and *en passant* we may just remark, that if the Harbour Trustees do not very soon settle upon a definite course of action in regard to this pressing demand, they will find that some private firms here are enterprising enough to deprive the Trust of a valuable addition to their revenue, by not waiting long to construct graving docks of their own. One firm at least have already done so, and we know of another contemplating the same addition to their establishment. It is notorious how small is the graving-dock accommodation in the Clyde that can be

Fig. 6.

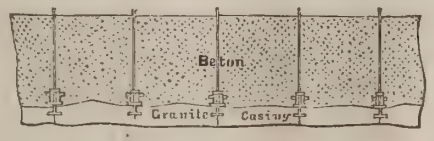


used by modern ships; while in reality the number of such docks is considerable; still they were constructed long ago to admit an altogether different and smaller class of shipping than now frequent this port, for the accommodation of which the greater part of them are useless.

We did not intend this digression when commencing to write the present paper; however, we feel that at the present time such remarks are necessary as another incentive to the benefit of the Clyde.

To return then. Since a definite plan was settled upon for the arrangement and dimensions of the harbour, it was decided to increase

Fig. 7.



the area of the Albert Harbour by building the south quay 90 feet further back than is shown on the plan, fig. 1,* thus necessitating the acquisition of additional land.

The cost of the different works will be—

Albert Harbour and Quay,	£150,000
Sea-wall and roadway of Esplanade,	20,000
Acquiring additional land,	50,000
Cranes, rails, &c.,	10,000
	£230,000

This work is a particular example of economical construction; for, as we have before shown, the immense cost of a coffer-dam has been entirely dispensed with; but as to the general adaptability of the methods therein utilized to several similar classes of marine structures, there can be no doubt that, under many circumstances, it would be useless to design a work to be so carried out.

If we examine carefully into the combination of the several parts—and we have done so somewhat critically—it is apparent enough that the casing forms a huge trough or coffer to receive the concrete and hearting; between which and the casing there is no positive connection whatever beyond that of the ties connecting the upper ends of the guide piling, and possibly a feeble adhesion of the béton to the inner face of the granite casing stones; there is, in fact, a decided want of bond throughout; still we are very far from alleging that the requisite connection between the casing and the body of the work may not be given to such a structure. Indeed, we are quite prepared to agree with the engineers, that the system admits of most extensive application to breakwaters, moles, harbours, &c., and other marine works, which might be founded on this mode of construction in the roughest localities where such works may be required; but we do not think that they have yet shown the best mode of applying it under such exposed circumstances.

* To dispose of the materials excavated for the harbour works, amounting to nearly half-a-million cubic yards, it is decided to construct an esplanade 100 feet wide along the shore of Fort Matilda, which will be faced on the seaward side with a wall 6000 feet long, having landing stairs opposite the principal streets, the wall being surmounted by an iron balustrade.

As far as breakwaters are concerned, many engineers have long looked upon the *pierre perdue* system as a mistake, both from its enormous cost, the non-permanence of its character, and the well-nigh endless task of execution. There could be no difficulty whatever in giving this system as much bond as the best example of ashlar ever produced, and this might very well be done by driving the guide piles thicker than in the example before us; using headers and stretchers as in ashlar, the stretchers being formed with a hole in one end that should fit over a guide pile, and having another hole towards one side from the centre of its length to pass over the next guide pile, while the further end of the stretcher should be of a form to pass into a V socket formed to receive it in the adjacent header. In this way each stretcher would embrace a guide pile at one end and another guide pile near about the middle of its length, the other end being firmly held by the recess in a header. Each of the headers would embrace a guide pile, and then might be extended back into the inner structure, as far as desired, until the requisite bond with the interior was obtained; indeed the bond might even be made more secure by forming the inner parts of some walls, having headers to spread out in a dovetail. In such a manner there can be no doubt that the strongest possible bond could be produced.

But with all the advantages that the stonework of the system admits of in securing stability and resistance, it seems at first sight natural to suppose that there might be a difficulty in securing the firm setting of the béton, especially, as in a rough sea, so much of the cementing material, lime and sand, would appear likely to be washed out by the surging action of the waves. In the discussion which took place on Mr. Miller's plan at the Institution of Civil Engineers, we feel bound, in passing, to say that we do not consider the system, and the modifications of which it admits, were there fairly dealt with. The example at Greenock was taken by those who entered into the discussion as the *beau ideal* of the system, which we maintain is certainly not the case; the works at Greenock, as they appear to us, being simply the adaptation of the system to a particular case, where it is exposed only to the weather and seas at the far inland end of the estuary of the Clyde, which are comparatively feeble in comparison with the fury of a storm in open sea or on the coast.

In truth, however, no difficulty has been experienced in getting the béton to set and to become thoroughly consolidated, even at a depth of 15 or 20 feet at low water, the concrete setting as solid as rock, and so hard that iron bars would not penetrate it.

In regard to whatever may appear doubtful after what we have said as to the adaptability of the system in turbulent seas, we cannot do better than append Mr. Miller's own words from the discussion :—

"He was astonished that so much misapprehension should still exist as to this material, and could only account for it by supposing, that the compounds in prevalent use for common purposes, and also called concretes, were confounded with the béton, or hydraulic concrete, as applicable to marine construction, and he attributed the failures to the bad materials of which the concrete was composed. The many occasions in which concrete had been successfully employed in works of this description were sufficient to establish its value. Of course, in the preparation of béton, certain precautions must be observed. The materials must be properly selected, thoroughly manipulated, and duly proportioned to the work for which the béton was required. If those conditions were attended to, he considered that béton, whether made from the naturally hydraulic limes, or from artificial cements, such as Portland, or even the rich limes rendered hydraulic by the mixture of other substances, such as pozzuolana, would certainly be successful, and would set like solid rock; and that any cases of failure must have arisen from the want of attention to these principles. Many examples might be adduced of the deposit of hydraulic concrete in sea-water with perfect success; but it was unnecessary to go beyond the Greenock sea pier. The béton used in that work was made from materials obtained within a few miles of the spot, and it had set hard in a short time. It had been doubted whether the whole mass was consolidated throughout; but the answer to that was, that it had been often tested, by means of iron rods, which even shortly after it was put down would not pierce it. It had also been examined by divers, who, when it happened that too much was deposited in one place, preventing the granite blocks from being properly bedded, found great difficulty in picking it away. The best test, however, of the uniform setting of the concrete was to be found in the stability of the walls. It was only natural to expect, if there had been any irregularity in the setting of the béton, that the walls would

have shown symptoms of settlement: but nothing of that kind had been noticed. With regard to the observations, as to the danger of depositing concrete in exposed situations, where it was apprehended the action of the waves might, to a certain extent, wash out the lime, leaving only the gravel and stones, he remarked that *this would not take place unless the concrete was put down in thin layers, and in that state was allowed to be acted upon by the waves. It should not, however, be employed in that manner, but in large masses, and continuously; and though it was possible that some of the lime might be washed out from the surface, yet this would be replaced by the mass of béton that followed, so that the homogeneousness of the whole mass would not be injured.* In illustration, he exhibited a specimen of the concrete, taken from the most exposed part of the Greenock Pier, which had been laid in a soft state, and was afterwards washed by the waves. In point of setting firm, nothing more could be desired. That concrete had been put down in a wet state, and was exposed to the action of the waves during the whole of the unusually stormy and severe winter of 1862-63, when several ships were driven from their moorings, in the vicinity of the harbour works, and the large steam dredger was wrecked on the new pier. This specimen showed that the danger to be apprehended from the washing out of the lime was not so great as had been supposed.

"With regard to the application of the principle to the construction of breakwaters, he considered it had been sufficiently tested to justify the further extension of the plan; and it must be recollected that the Greenock sea pier was essentially a breakwater. In the construction of similar works in more exposed situations, it would only be necessary to make them stronger in proportion, and to take precautions according to the circumstances. There might be danger to the concrete from the action of the waves in a stormy sea; but he proposed to build the work in sections, with cross walls, or casings, at given distances, so that the facing and the béton work would be carried on together, and in that way the concrete would only be exposed to the wash from the surface, which he had shown was not very serious. Breakwaters had been constructed of timber frames filled with loose rubble stones, and these had withstood, successfully, the assaults of the waves. A structure of wrought iron with a stone casing, even though filled in with only loose rubble, would be much stronger than this; but when in addition the interior mass would be concreted like solid rock, he submitted that such a structure would combine all the conditions required for attaining the greatest stability and durability in the construction of breakwaters."

Now without endorsing the whole, especially some of the latter, of Mr. Miller's remarks, it seems to us that, as far as the deposition of the béton is concerned, there is little room for apprehension except in the case of a work in a rough sea, and this only when it approached the water surface; for the disturbing effect of the waves diminishes in some large ratio to the depth, and even in cases where there is really ground to guard against this separating action, it is quite possible to carry up the casing high enough above water, and then deposit the concrete to be situated at the stratum of maximum wave-disturbance, by which proceeding it is certain the lime and sand could not be washed out.—V. D.

HARTLEPOOL HARBOUR.

Several years since we published in this Journal* a proposal of Messrs. T. Richardson and G. W. Jaffrey, for providing an improved harbour at Hartlepool; the condition of which at that time was exciting anxious consideration on the part of those persons concerned in the well-being of that port.

The Hartlepools themselves are well provided with shipping accommodation in the shape of docks; but it has long been felt a desideratum to obtain secure anchorage for vesssels that are not let into dock, whilst the roads into the dock are much in need of improvement.

Various plans for improving the harbour have from time to time been proposed; amongst others, Mr. Rendel's consisted in constructing piers, one commencing at the southern part of the bay opposite the islet of Long Scar, extending over the Scar; the other, commencing at the north-eastern point of Hartlepool headland, and extending into the sea in an easterly direction; both piers approaching each other at about mid-distance from their point of commencement, leaving a wide entrance for the shipping. A part of the latter pier has been proceeded with, but the works were not continued through want of the necessary capital. A cotemporary states that "more recently the Port and Harbour Commissioners have been proposing to carry out a slight modification of a plan designed by Mr. Mossman, this consisting in the construction of two close piers," inclosing but a very limited area; and we think if this work is carried out, it will not ultimately be found to effect the object desired, being situated too far inward, and its entrance being contracted so much, the port would become a difficult one to make in bad weather.

During the last few months Mr. Jaffrey has been urging again his conjoint plan with Mr. Richardson; and for the advantage of those of our readers who are not in possession of the part of this Journal referred to in the foot note, it may be mentioned that the proposal consists in constructing a series of iron towers 31 feet high above low water, and 16 feet above high water, so that when these are deposited in the sea, at the predetermined distance asunder, they extend outwards, and partially inclose the required extent of sea room. The towers are of a circular figure in transverse section, wide at the base and tapering towards the upper part, and are formed of cast-iron plates having internal flanches for receiving the bolts by which they are held together. The towers are constructed on land, and left open bottomed, are taken out to sea in succession upon a pontoon, or other suitable floating apparatus, and then sunk upon the spot required; although it is also proposed to convey them to their position by some barges having a forked stem, in the hollow of which each tower would be suspended, so that it could be readily lowered by gear on board the barge.

After the piers are in position they would be filled with blast-furnace slag, ballast, or other material at hand, and connected together above low-water mark by a series of cast-iron tubular stays. The operation of filling up the towers with masonry or other materials is facilitated by the convenience which the summits of the towers afford for at once laying down a way from one tower to another, along which materials and implements can be conveyed with the same facility as on shore.

The probable cost of the whole undertaking is estimated by Mr. Jaffrey at £120,000; and as it is now reported that the Harbour Commissioners have this sum at their disposal, it is not improbable that Mr. Jaffrey's plan will be carried out.

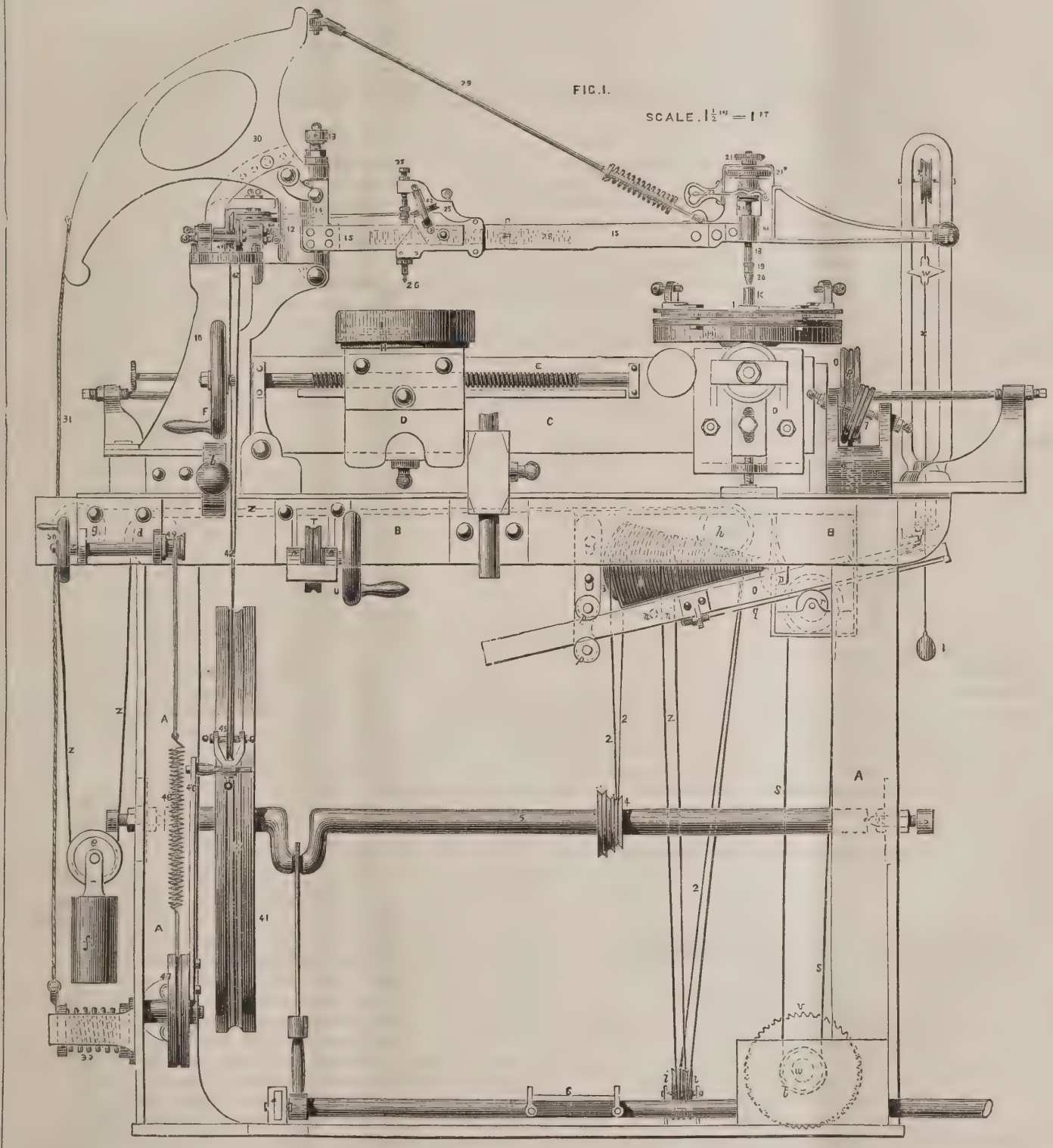
The tidal currents which set in from the North Sea carry considerable quantities of sand in suspension; the flood current entering from the north-east curves round to the west, and again to the north, along the inner side of the bay, whilst the ebb current takes a direction principally north-east. At a time when the north-easterly winds blow, they, of course, check the ebb; the consequence of which is, that the sand brought in by the flood is deposited, thus producing the bar which it is partly the purpose of these proposals to obviate.—V. D.

* *Vide ante*, Plates 247-249, and description, November and December, 1859.

MEDALLION ENGRAVING MACHINE.

An exceedingly ingenious although necessarily complex machine, for engraving reduced copies of medallions and matrices, has been recently patented by the inventor, Mr. Charles John Hill, an engraver and die-sinker of Albany Street, Regent's Park. This machine, of which we give several illustrations, was constructed entirely by Mr. Hill himself, and reflects the highest credit upon him, not only as a first-rate workman, but as a mechanician of no ordinary ability. The principle upon which the machine works is that of the pentagraph; a tracer point, by traversing over the surface of an enlarged copy of the work to be produced, giving the corresponding but diminished movements to a rotatory cutting tool, which operates directly upon the work. Messrs. Wyon, the well-known engravers, of Langham Place, Regent Street, have purchased Mr. Hill's patent rights, and are now working the machine on their own premises, where it has been for several months in constant operation, under the immediate superintendence of the inventor. Fig. 1 of our engravings represents a side elevation of the machine drawn to a scale of one-eighth—Fig. 2 is a plan of the same, the rest of the figs. are details of various parts. A A are the two standards of the machine, supporting a table, B, upon which rest, and to which are attached, the various portions of the machine to be shortly described. Along and upon about three-fourths of this table, B, there is placed what may be called the bed, C, so formed as to admit of two V-grooved heads, D D′, being attached thereto: the one, D′, at the right hand of the machine is fixed; the other, D, when requisite is caused to slide along the bed, C, to the position required by a screw, E, connected with the same and with the bed, which screw extends along the front of the bed, and when used is turned by a hand-wheel, F. Fig. 3 represents a detail sectional elevation

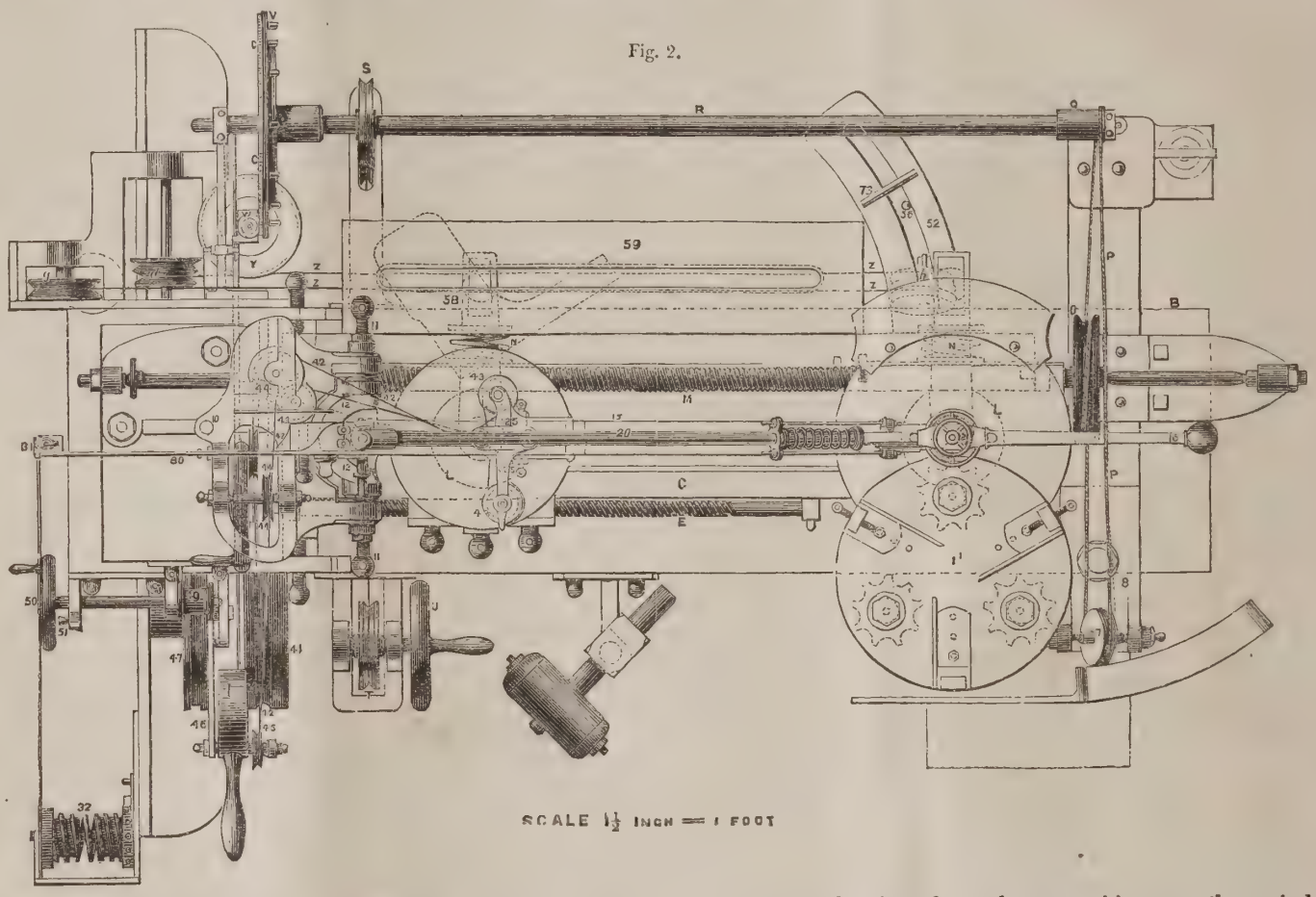
of the fixed head, D′. These heads each contain a vertical mandrill, one of which is shown at G′, in fig. 3, to the tops of which are screwed the horizontal circular revolving tables, H H′. To the table, H, attached to the head on the left-hand end of the machine, there is attached a receiver or chuck, I, for containing the die or material to be operated upon; and to the other table there is attached an adjustable chuck or holder, I′, for containing the enlarged pattern to be traced from. In the centre of the pattern table, at the right-hand end of the machine, there is a raised pillar, K, the centre of the top of which coincides with the centre of the corresponding mandrill; the object of this arrangement is to admit of the proper adjustment of the mandrill supporting the work to the point of the cutter. To about the middle of



each of the mandrills there is attached a worm wheel, L L′ (shown dotted in fig. 2), and to these worm wheels a screw, M, which extends the whole length of the bed, is made to press by the agency of spiral springs, N, fixed in cases at the back of the screw, which is so held as to be rigid, except in a direction towards or from the worm wheels, L L′. The screw, M, is caused to revolve, and by acting upon the worm wheels to turn the tables at various speeds, according to the discretion of the operator, by gearing described below. Attached to the right-hand end of the screw there is a pulley, O, which is connected by a gut band, P, with a smaller pulley or drum, Q, at the back of the machine, which drum is fixed at the right-hand end of a spindle, R, extending nearly the whole length of the machine. The spindle, R, carries another pulley, S, over which and under the guide pulleys, *a*, a gut band, *b*, passes, which is brought over a pulley, T, attached to the front part of

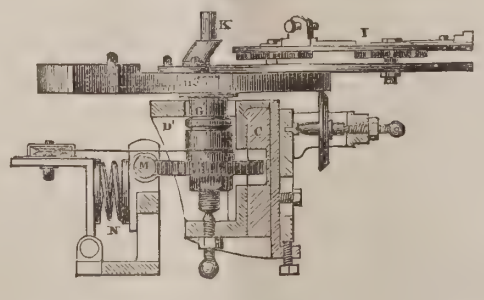
the machine, and when used is turned by a hand-wheel, U. The object of this arrangement of bands and pulleys is for the purpose of adjusting the work to the cutter by a quick motion of the screw, M. At the left-hand end of the spindle, R, and attached thereto, is a circular plate, V (fig. 2), from the outer side or face of which project circles of teeth or pins, *c*; the spindle, R, upon which the plate, V, is fixed, being concentric to these circles. These teeth or pins, *c*, are acted upon by an endless screw, W, which is attached to the top of a vertical spindle, X, at the lower end of which there is a two-grooved drum or pulley, Y (fig. 2), which is made to revolve by a gut band, Z, passing round one or other of the two grooves in such pulley. One portion of this band, Z, passes direct from the pulley, Y, over one of the grooves in the guide

Fig. 2.



pulley, *d*, thence under the pulley, *e*, contained in a weight, *f*, to afford an equal tension of the gut band. It then passes up over the guide pulley, *g*, along the back of the machine, near the right-hand end of which there are two grooved guide pulleys, *h*, over which both parts of the band pass, the one downwards and the other upwards, and under the guide pulleys, *i i*, at the base of the machine. From these pulleys, *i i*, it passes up to and over a long conical drum, *k*, grooved annularly from end to end, which revolves on centres screwed into a frame

Fig. 3.



attached to the under side of the main table, B, of the machine. The screw, W, is made to gear into any of the circles of teeth or pins, *c*, in the flat circular plate, V, or to take a position between them, and thus remain out of gear by the aid of a weighted lever or bar, *l*, connected to the frame, *m*, which holds the spindle, X, carrying the screw, W, and the two-grooved drum or pulley, Y, such bar being provided with notches which take into a catch or projection in front of the machine, the locking of a particular notch determining the position of the screw, W. The gut band, Z, is made to take any position upon the conical drum, *k*, by being held between two small revolving guide rollers, *n*, which are attached to a flat bar, *o*, made to move to and fro longitudinally in front of the long conical drum through suitable guides, *p p*, by a gut band, *q*, attached to each end of it, passing once or twice round a pulley or drum, *r*, upon which one end of the bar, *o*, rests. Another gut band, *s*, passes over another and larger portion of the same pulley or drum, *r*, and under another pulley, *t*, at the base of the machine, which is carried by a spindle, *u*, to which is also attached a notched or roughened wheel, *v*, turned to the right or left by the foot of the operator, who thus adjusts to the required position the gut band, Z, on the long conical drum, *k*, according to the desired speed of rotation of the two chucks, I and I′, which respectively hold the work and the pattern. The position of the gut band, Z, on the conical drum, *k*, is shown by an indicator, *w*, attached by a thin gut or cord, *x*, to the right-hand end of the flat bar, *o*, which is conducted by the guide pulleys at *y* over an overhead pulley, *z*, at the back of the machine, and has a weight or drop, 1, attached to its lower end. The conical drum, *k*, is connected by a crossed gut or band, Q, passing over a deep groove, 3, situated at the left-hand or largest end of the drum, *k*, with another drum or grooved pulley, 4, carried by the crank shaft, 5, which turns on centres in the main standards, A, of the machine. The crank shaft is driven by a foot treadle, 6, in the usual way, or by a band and pulley, or otherwise.

Fig. 4.

The operation of this part of the machine is as follows:—Circular

motion being given by the foot or other power to the shaft, 5, the pulley, 4, attached to it is caused to revolve, which having a gut band, 2, round it and round the deep groove, 3, of the long conical drum, *k*, the same is also caused to revolve, and having another gut band, Z, over it, transmits motion to the pulley or two-grooved drum, Y, at the base of the spindle, X, carrying the worm or endless screw, W, at the top. This latter, by gearing with the teeth or pins, *c*, projecting from the flat plate, V, fast on the spindle, R, at the back of the machine, causes the same to revolve, and consequently drives the drum, Q, which is connected by the gut band, P, with the pulley, O, on the right-hand end of the long screw, M, thus transmitting motion to such screw, which, being geared with the worm wheels, L L′, attached to the mandrill in the heads, D and D′, causes the same to revolve and impart a circular motion to the chucks, I I′, for holding the die or substance to be worked upon and the pattern respectively. The upper part of the said band or gut, P, passes direct across the end of the machine from the upper surface of the pulley, Q, over the guide pulley, 7, which is carried in an adjustable bracket, 8, connected to the table, B, of the machine. From the under side of the pulley, 7, the gut, P, passes round the guide pulley, 9, and over the pulley, O, whence it passes round the second groove in the pulley, 9, and returns to the pulley, Q, on the under side thereof. To the left-hand end of the main table of the machine, and joining the bed, a strong support, 10, is attached, to the top of which, suspended by horizontal centres, 11, is a head, 12, to which is attached, by vertical centres, 13, screwed through the same, another head, 14 (the two together forming an universal joint), to which are bolted two flat parallel bars, 15, disposed one on each side of the head, 14. These bars extend towards the right-hand end of the machine, where a handle, 16, is provided, by which the operator guides the tracer and cutting tools, as hereinafter described. The parallel bars, 15, extend over the two tables, H and H′, and chucks, I and I′, and at their right-hand ends they are bolted to the opposite sides of the bracket or frame, 17. This frame, 17, should be so situate as to be capable of passing over the centre of the right-hand mandrill, G′, which turns in the fixed head, D′, and it carries a vertical adjustable cylindrical spindle, 18, at the lower end of which a nose, 19, is screwed, to which tracers, 20, of various sizes and shapes, are also screwed. The upper portion of this rod is screwed, and it is raised, lowered, and fixed by back and front set nuts, 21. 21′ is a spring which tends always to keep the spindle, 18, and the steel bush attached to the lower nut, 12, through which the spindle is screwed, jammed in an upward direction. It is also provided with a longitudinal slot, into which a guide is forced by a spring, for the purpose of guiding the same and preventing the spindle from turning when being adjusted. A small indicator or finger, 23, centred to the frame, 17, and resting upon nuts, 24, carried by the spindle, 18, which carries the tracer point, serves to indicate the length or amount of wear taking place in the cutting tool hereinafter referred to. Another frame, 25, carrying the cutting tool, 26, is also attached to the two parallel bars, 15, before referred to, which can be moved along the same to any required position; this is effected by a pinion, 27, carried by the frame and gearing into a rack, 28, extending along and contained between the parallel bars, 15. The varying weight or strain on the bars, 15, according to the position of the movable frame thereon, is compensated by means of a tension rod, 29, attached to such bars, and connected by a bell crank, 30, and gut, 31, with an adjustable spring, 32, attached to the lower portion of the left-hand standard, A, of the machine. The bars, 15, are kept elevated when the machine is out of action by a pin passed through the bell crank, 30, and into one or other of a series of holes made in a curved bracket, as shown clearly in fig. 1. They are also locked or prevented, when out of action, from swinging laterally by a pin passing through an arm jointed to the bell crank, 30, and entering a hole in the head, 14, to which the bars are attached. When commencing a piece of work, a strong mandrill, 33 (see detail fig. 4), is placed in the movable frame, 25, in a vertical position, being held by a collar, 34, below, and a centre screw, 35, above. To a holder, 36, screwed into the lower end of this mandrill, there is screwed a rose cutter, 26 (shown in enlarged detail at fig. 5); but when the finer operations have to be performed, the mandrill, 33, is removed, and a lighter one, 37 (shown in detail elevations at fig. 6), is substituted, carrying differently formed cutters hereinafter described. In this case a temporary collar, 38, is to be added, which is firmly held down by a lever, 39, acted upon by a screw, 40, both of which are contained within the movable frame, 25. The end of the lever, 39, is provided with an inclined projection which engages with a V-notch in the temporary collar, 38, by the action of the screw, 40, thus holding the collar or loose bush in its place. These mandrills are driven from the large wheel, 41, fast on the crank shaft, 5, by a thin gut or band, 42. This gut passes round a sheave on the mandrill, and thence round one of the guide pulleys, 43, carried by the frame, 25; it then returns round the opposite side of the sheave on the mandrill, and round the

Fig. 5.

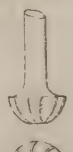


Fig. 6.

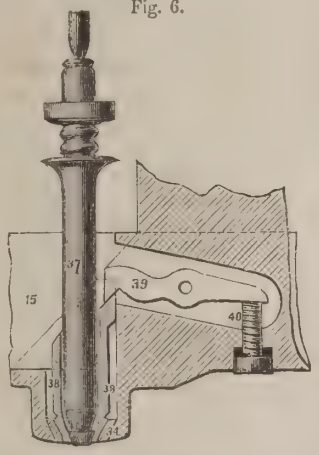


Fig. 7

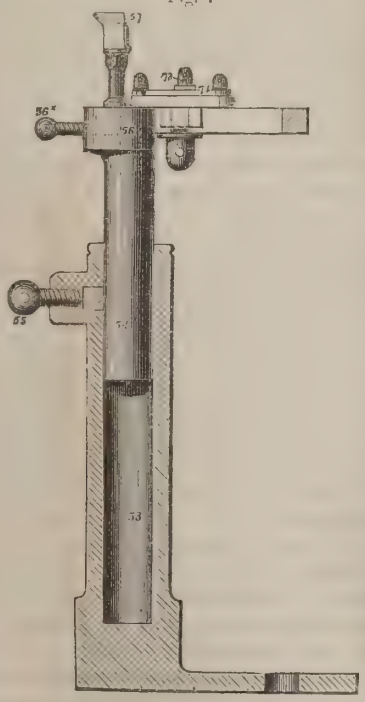


Fig. 8.

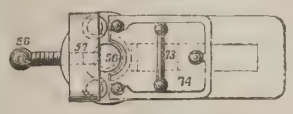


Fig. 9.

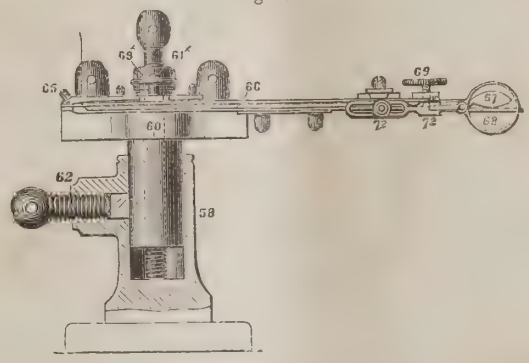
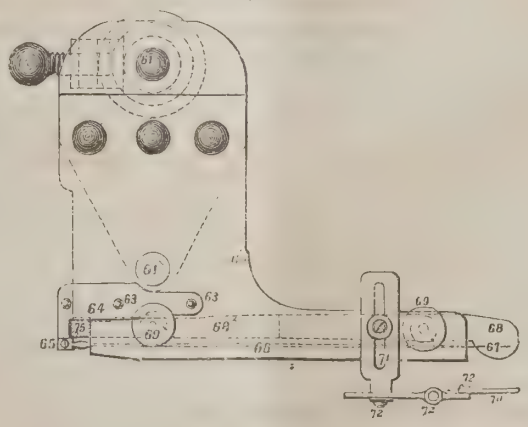


Fig. 10.



second of the two guide pulleys, 43, whence it returns to the sheave on the mandrill, and both parts of the gut then pass over the horizontal and vertical guide pulleys at 44, and thence pass round the large wheel, 41. The proper amount of tension of the gut is maintained by passing it round a pulley, 45, carried on the end of a light adjustable arm, 46, in front of the large wheel, 41, which arm is attached to a pulley, 47, and made to increase or diminish the tension of the gut band, 42, by the action of a spiral spring, 48, in connection with such pulley and with a drum, 49, and hand-wheel, 50, provided with holes for locking on to a catch, 51.

The following are the means for ascertaining the correct length of cutter with relation to the tracer:—At the back of the right-hand end of the machine and attached to a curved slotted bracket, 52, level with and fixed to the side of the main table, B, there is fitted a horizontally-adjustable vertical socket, 53 (shown in detail, fig. 7), carrying a vertically-adjustable spindle, 54, fixed by a lateral set screw, 55; on the top of this spindle there is provided a horizontal smooth surface, 56 (the position of which only is shown in fig. 2), so situate that the tracer point, 20, can be readily brought over and made to rest upon the centre of such smooth surface, the rod or stem of the tracer being pressed against a guide bar, 57, in order to insure the placing of the point of the tracer on the same spot at each separate adjustment; that is to say, each time the cutter has been removed for sharpening or for changing for another form of cutter. This smooth surface consists of a hardened piece of steel, which is let into the top of the adjustable spindle, 54, and projects slightly above it, as shown in dotted lines in fig. 7, a set screw, 56′, serving to hold it in its place. Another movable socket, 58, is made adjustable along the slotted plate, 59, which is bolted to the main table of the machine, the position of such socket being indicated by dotted lines only in fig. 2. At figs. 9 and 10 an enlarged detail sectional elevation and plan of this socket, with the parts connected therewith, are represented. Within this socket there is fitted the stem of a vertically-adjustable table, 60, carrying an overhanging plate, 60′, which may be roughly adjusted to any desired height by the vertical adjusting screw, 61, and fixed in position by the pinching screw, 62. To the front edge of the plate, 60′, and at the left-hand corner thereof, there is fitted, by means of the adjusting screws, 63, a plate, 64, to which plate is secured the end, 65, of a long flexible arm or indicator, 66, the free end, 67, of which should, in its adjusted position, be so nearly in contact with the surface of the plate, 68, situate beneath it, that the finest possible line of light can be seen between them. The object of the plate, 64, is to enable the indicator to be suspended in a central position between the plates, 60′ and 68. The plate, 68, is also attached to the plate, 60′, and is capable of adjustment towards or from the under side of the plate, 60′, by the screw, 69. 70 is a powerful magnifier attached to the plate, 60′, adjustable in any desired position by the aid of the slotted plate, 71, and joints, 72, the object of this magnifier being to facilitate the observation of the exact position of the end of the indicator as regards the plate, 68.

Fig. 11.

The mode of ascertaining the exact size of cutter in relation to the tracer consists as follows:—Behind the horizontal smooth surface, 56 (see figs. 7 and 8), there is a small Λ-shaped projection or ridge, 73 (the position of which is indicated in fig. 2), attached to a sliding plate, 74, so arranged that by placing the said tracer point on each side alternately of the ridge, and moving such ridge laterally a distance equal to the width of the ridge at its base or broadest part, and by turning the cutter, which is at the same time brought on to a piece of wax or other suitable impressible material, 75, placed on the end of the plate, 68′, at the back of the indicator, 66, hollow dots will be produced in the wax, which dots, if perfectly round and just touching one another at their circumference, and their depth being equal to half their diameter, will indicate that the size of the cutter is correct in relation to the size of the tracer. An adjusting screw, 69′, serves to elevate the wax surface until the point of the cutter sinks to the proper depth therein. In using this machine, the operator first adjusts his work on the chuck, I, and the enlarged copy of the medallion on the chuck, I′. He then adjusts the position of the movable frame, 25, along the bars, 15, according to the amount of reduction required; the smaller the copy the nearer will be the frame, 25, to the left-hand end of the machine. He then adjusts the head, D, with its chuck, I, holding the work, so as to bring the centre of the mandrill which carries the chuck under the point of the cutters. The height of the cutter, 26, and tracer point, 20, is now adjusted, so that a horizontal line drawn through the centres, 11, shall just touch the points of the cutter and tracer respectively, the bars, 15, being at the same time also in a horizontal position. The pattern is now raised by suitable adjusting screws until the medium depth or height just touches the point of the tracer, after which the work is similarly elevated until it comes in contact with the point of the cutter, where it is fixed by screws or other means. The size of tracer is then selected according to the work to be produced, and the relative size of cutter as regards the tracer ascertained by the use of the wax surface hereinbefore referred to. The machine is now ready for operation, but in order to insure the placing of the cutters subsequently employed at the same height as the one already adjusted, the bars, 15, are moved laterally, so as to bring the tracer point upon the smooth surface, 56, which movement will bring the point of the cutter over the indicator, 66, carried by the vertically-adjustable plate, 60′. This plate is then elevated by the screw, 61, until the fixed end of the indicator is brought nearly in contact with the point of the cutter. The finer adjusting screw, 61′, is now brought into action until the indicator comes into actual contact with the cutter, the point of contact being shown by the red line in fig. 17; the instant that contact takes place will be clearly shown by the dipping of the free end of the indicator, the adjustment being continued until only the faintest line of light can be observed between the end of the indicator and the surface of the plate, 68. As the cutter wears shorter it is lowered by screwing up the tracer spindle until the point of the cutter deflects the indicator, 66, to the same amount as it did in the first instance, the tracer point resting at the same time upon the smooth surface, 56. The operator then draws the bars, 15, forward so as to bring the tracer point, 20, over the medallion, and the cutter over its work; and the machine being started, a rotatory motion will be conveyed to the cutter by the band or gut, 42. The screw, M, transmits at the same time a rotatory motion to the chucks, I and I′, and the operator then traverses the tracer and cutter to and fro over the work and pattern until the entire surface has been roughened out by the aid of the rose cutter or roughening tool, fig. 5. He then inserts the smaller mandrill and temporary collar with the finer tool of the shape shown in fig. 11, and continues the operation, using finer tools as the work approaches completion. Mr. Hill has also invented some ingenious little machines for preparing and manufacturing the cutters employed in the medallion engraving machine, which our space will not permit us to notice further.

EQUILIBRATED SLIDE-VALVES.

(Communicated.)

SINCE the days of James Watt, the theory of the forces acting on the slide-valve has engaged the attention of almost every engineer of any repute. Upwards of 5000 of them have taken patents for what the patentees supposed to be equilibrated slide-valves, but of that number, it is believed that two only have any legitimate claim to that distinction—viz., one by Thomas Adams, of London, the other by Wilson, of Patricroft, both being mathematically equilibrated, but neither of them available as such in practice, because an equilibrium slide-valve to be so available must possess the following elements:—It must be as easily moved under steam of any pressure as in the open air, be absolutely steam-tight, and so arrange itself to the irregularities and inequalities of practice, as will prevent the possibility of derangement, or even the attendance of the ordinary requirement of a lubricant, and be at the same time cheap in first cost. Any slide-valve failing to fulfil those conditions is open to both criticism and improvement.

The mathematically equilibrated slide-valves just mentioned are each so constructed that the steam from the boiler presses on equal and opposite sides of the external surface, and the exhaust pressure also presses on equal and opposite sides of the internal surface, and the variable pressure within the cylinder also acts equally and opposite on the back and face of the valve. And as the whole of the respective areas are equal and opposite, it follows that the steam, no matter how variable its force, cannot touch this valve on any one point without touching it on an equal and opposite point, and practically at the same instant of time, and hence a perfect and mathematically equilibrated slide-valve. But although theory should be the handmaid to practice,

it does happen that they sometimes disagree, and the present is a case in point. Since the atoms of metal have to sustain the pressure, it follows that this valve cannot suffer either deflection or compression; but the whole of the surfaces, cylinder face, valve, and door or plate against which it works must be as rigid as metal can make them. So obstinate and unfriendly are they that the one will neither give to, nor take from, the other; the one will in no way arrange itself to meet the requirements of the other, but each one constantly endeavouring to become more persistent than the other, acting on its own independence. And as the atoms have to submit themselves to heat, and equal increments of heat expand equal quantities of metal of equal qualities of composition equally, and as heat is not at all times equally applied in practice, the result is, that these rigid surfaces, to be made tight with steam on, must touch each other, although only slightly. The expansion of the metals is equal; but on shutting off the steam from a locomotive running into a station or down an incline, every stroke of the valve generates heat by friction, the valve becomes hotter than the steam-chest, expands and sticks fast, and the spindles are instantly carried away, so that a period is thus put to the existence of a mathematical equilibrium slide-valve. A mathematically balanced slide-valve is therefore not the valve adapted to practice; what is wanted, as we have before said, being one which will give and take to the irregularities of workmanship and the inequalities of temperature; simple in construction, and cheap in first cost, move as easily with steam of any pressure on as off; be absolutely steam-tight, and beyond the reach of a break-down from causes attending its working. That the slide-valve of Thomas Adams, illustrated by him at the meeting of the Institution of Engineers in Scotland, held in Glasgow on the 10th ult., possesses these qualities in a high degree there can be little doubt; and this is easily gathered, not only from the author's paper, but from the evidence adduced in the discussion and otherwise. Mr. Cowan, locomotive superintendent of the Great North of Scotland Railway, stated that he had ten engines fitted with these valves, and was applying them to the whole of his stock; and as an illustration of how easily they are moved under steam, he said that he placed one of his largest engines, exclusive of the tender, between two other engines, with only an engine length between them, the reversing lever standing in mid-gear, and with steam of 140 lbs. pressure per square inch, and the regulator placed full open. He took the reversing lever in his one hand, and put the engine first into fore-gear, then into back-gear, and so on, causing the engine to oscillate to and fro in that short distance without striking either of the other engines. Mr Cowan further stated that the valves were as easily reversed with steam on as when it was off, and that on those large engines with the ordinary valve, all the men who could get about the lever could not so reverse the engine.

As evidence of these valves being steam-tight, he also stated that, with steam full on, he can with safety place his hand over the blast orifice; and that the benefits accruing from their application were, that the engines could take 11 per cent. greater load than with the ordinary valves, whilst the cost for repairs of the link motion, eccentrics, straps, &c., was reduced.

Mr. Angus, of the North Staffordshire Railway, in testing its tightness, placed one valve in mid-position, fastened the wheels so that they could not revolve, took the front cylinder cover off, and let steam full on; he then put his hand into the port by the open end of the cylinder, and also down the blast orifice. Engineers will appreciate what such a feat means.

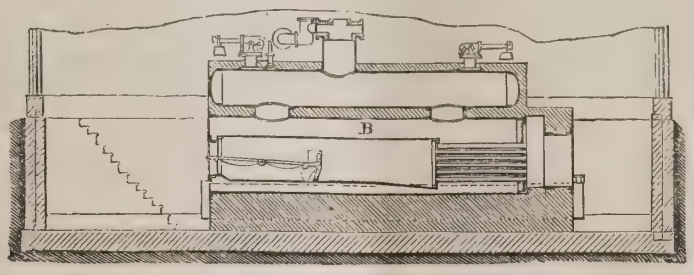
As evidence of the tear and wear of these valves and the valve-gear, Mr. James Johnston, of the North Staffordshire Railway, in writing to the author says,—"I have been at Stratford (Great Eastern Railway Works), and my son Samuel Johnston, locomotive superintendent, had these valves taken out for examination, when we saw the scraper marks still on the valve face after fourteen months' constant work; not a pin of the motion or an eccentric strap had worn loose."—Y.

[As nearly the whole of the railway superintendents have adopted this valve, we purpose shortly publishing a paper by Mr. Adams himself, giving a full description of it, and illustration of experiments that led to the discovery of the forces acting on the slide-valve, with a clear and distinct explanation of these forces.—V. D.]

STEAM GENERATORS EMPLOYED AT THE FRENCH EXHIBITION.

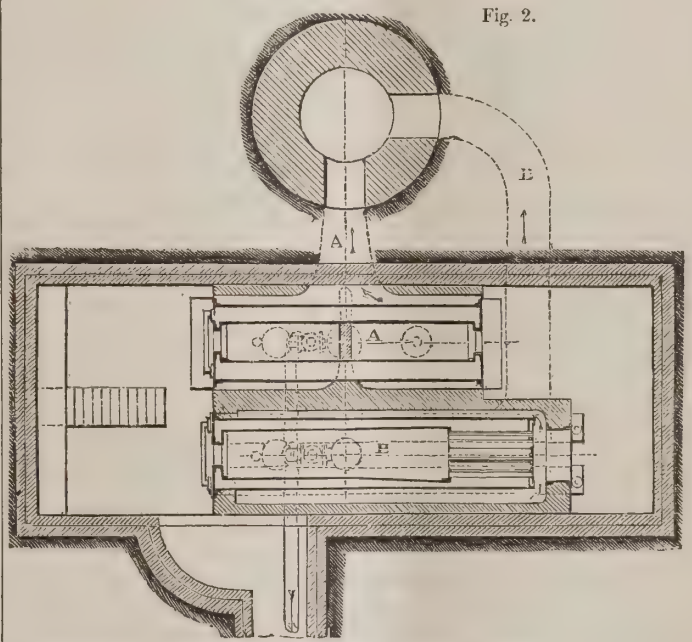
THE accompanying woodcuts illustrate two forms of steam generators erected at the French Exhibition building for driving the exhibited machinery. These generators were constructed at the works of the

Fig. 1.



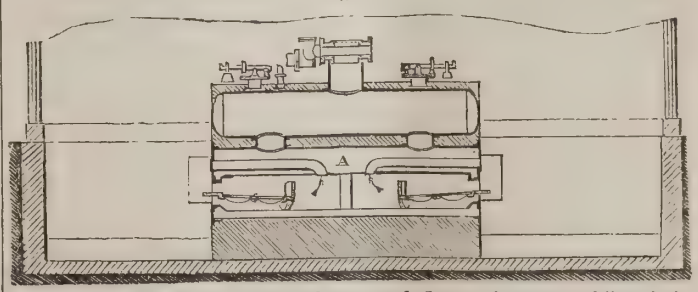
well-known firm of Chevalier et Duvergier, of Lyons, and contain many excellent points worthy the notice of our readers. Fig. 1 is a longitudinal vertical section of the boiler, marked B; fig. 2 is a sectional plan of the two boilers, A and B; fig. 3 is a longitudinal vertical section of the boiler, A; and fig. 4 is a transverse vertical section of the two

Fig. 2.



boilers together. The boiler, A, which we shall describe first, is provided with two removable furnaces, situate one at each end of a cylindrical flue, and separated by a central division wall, as shown clearly in fig. 3. Along the exterior of the cylindrical flue, and passing through the surrounding water space are a number of return tubes, the inner

Fig. 3.



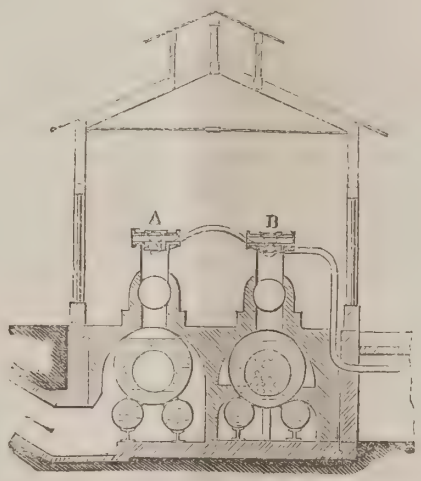
ends of which are curved into the central flue or furnace, whilst their outer ends communicate by a flue surrounding the boiler with the main chimney, as shown in figs. 2 and 3. It will thus be seen that the flames from each furnace circulate independently and in opposite directions through the bent tubes above referred to, after which they unite in the

common flue surrounding the boiler, and then circulate under the two cylindrical water heaters to the main chimney. This boiler is so constructed that it is possible, by cutting it in halves transversely, to form two boilers, similar to those which M. Chevalier has constructed for the steamboats on the Seine.

In the boiler, B, a single furnace only is used. This boiler is similar to those constructed by M. Chevalier for nearly all the bakehouses for the French army; three of them are now at work at the army bakehouse on the Quai de Billy.

As will be seen from the woodcut, fig. 1, the combustion chamber is made the most of, and the tube plate is removed some distance back

Fig. 4.



from the grate; the clearing of the tubes is greatly facilitated, as well as their removal. A smoke box permits of the ready introduction of a brush into the tubes, and of their examination; whilst, at the same time, the flame and heated products of combustion circulate through flues surrounding the cylindrical water heaters. As the water and steam spaces are both large, a considerable regularity in the production of steam is insured. The shell is constructed of Bessemer steel or wrought-iron plates, whilst the body of the furnace is of cast steel plates.

These boilers are each equal to forty horse-power (nominal); the boiler, A, has a heating surface of 65 square metres, and the boiler, B, a heating surface of 67 square metres. The steam is taken off from the steam drum at the top by a pipe, which is conducted along an underground gallery to the machinery department of the building.

CHILLED TYRES.

Why don't British engineers employ chilled tyres? is a question not unfrequently asked by foreigners; a very right question, too, to the solution of which the only impediment that exists is an unreasonable prejudice. Yet, strange enough, with such a fact at home, it is the British engineer who has been principally instrumental in their introduction abroad; and we may feel sure that the success which has there accrued in so many cases will ere long open the eyes and understandings now half closed here.

Amongst others, we now wish briefly to draw attention to what has been done on Russian railways by Messrs. Lischine and Handyside, engineers, at St. Petersburg. The wheel and tyre which they introduced there some three years ago has been established on the railways in that country with a maximum of good result. In all probability no wheels or tyres were ever previously submitted to so searching a testing ordeal, the particulars of which we shall shortly place before our readers. The wheel and tyre is patented in this country as a communication to Mr. St. J. V. Day, and is described at pages 320–21, vol ix., *Practical Mechanic's Journal*, Second Series.

These cast-iron tyres having so completely fulfilled everything that the manufacturers promised for them, has induced the establishment of works in Great Britain for their production, and Mr. Handyside is at present in this country for that purpose. The works are to be established in Glasgow. Amongst other advantages, the first cost is less and the mileage greater; whilst if the tyre happens to break in several pieces, it cannot, from the mode of construction, leave the wheel; indeed, tyres have been run in this broken condition for many hundreds of miles, for the purpose of testing their durability.—V. D.

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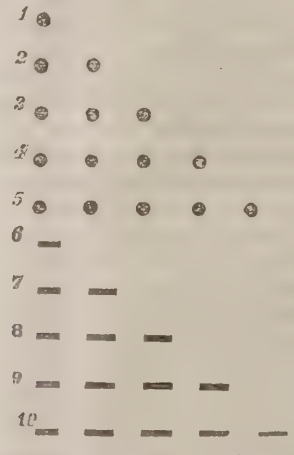
RECENT PATENTS.

TRANSMITTING MESSAGES BY THE ELECTRIC OR MAGNETIC TELEGRAPH.

Captain F. J. Bolton, 13 *Bruton Street, Middlesex.—Patent dated 19th June*, 1866.

This invention relates to the employment of a written or printed code of signals, and to the manner of arranging and using such code when it is desired to communicate intelligence by means of the electric or magnetic telegraph. A code, that is, a list of letters, words, sentences, or numbers in a tabulated form, having been prepared, the pages of the code are numbered in consecutive order, and also the lines on each page; and when it is wished to send a message from one place to another, the number or numbers are simply transmitted (by any of the means employed in the transmission of messages), referring to the page and to the line in the code where is to be found the letter, word, sentence, or number which it is desired to acquaint the correspondent with.

The code employed is so arranged that—1, All words and letters of the English language can be expressed by groups of figures; 2, All words and letters of any other language capable of being rendered in the English characters can also be likewise expressed. The object of this system of signalling is to facilitate the speed of transmission of messages, and to prevent the liability to error in the rendering of a message. The telegraphic symbols used to express this code are the dot and the dash, which have been used before in the system known as the Morse system. The following arrangement is employed to signal the numbers:—



By this arrangement the necessity of mixing dots with dashes is obviated, errors arising from the use of a combination of both are avoided, and the signals are equally simple and effective, whether used with a short and long signal or right and left deflections, the latter being the most expeditious. The code is divided into five parts, and they are as follows:—

Part 1 provides for 110 signals, and expresses the letters of the alphabet, which alphabet, though numerically symboled, resembles the ordinary Morse alphabet, except that where necessary changes are made, so that the necessity of mixing dots and dashes is obviated. This alphabet, however, will be seldom required. Of these 110 signals, 10 are expressed by one figure, the remaining 100 by two figures.

Part 2 provides for 1000 signals, limited to three figures, and forms the "spelling code," by which any word in any language having English characters can be spelt by syllables.

Part 3 provides for 10,000 signals, limited to four figures, and forms a special code applicable to commercial and political intelligence, and frequently recurring names of places, months of the year, days of the month and week, time, hours, and dates; and as these signals are sure to be of frequent occurrence they are denoted by short groups of figures (limited to four places).

Part 4 provides for 100,000 signals, limited to five figures, and expresses every word in the English language, alphabetically arranged, and such sentences as are coded, and is called the "vocabulary and sentence code," the latter of which is employed to denote such sentences and series of words as are most likely to occur in telegraphic messages.

Part 5 provides for 127,000 signals, limited to six figures, and expresses the name of every known place in the world; an abstract of which, including the principal places likely to be referred to in messages, is incorporated in Part 3.

Each part (intended to be referred to) is readily distinguishable by the number of figures in the group; for instance, a group of three figures must refer to Part 2, which provides for signals limited to three figures, or multiples of the same, and which is designated as the spelling code, and a group of five figures to Part 4, and so on. In the formation of this method of codification, a system of page and line has been established, indicating by a single glance at the group of figures the particular page and line in the code book to which they refer, thus considerably facilitating the rendering of messages from code into ordinary language; for instance, every page in the code has 100 lines, numbered from line 00, 01, 02 to line 99, inserting a cypher before the unit numbers up to 9 inclusive, and the pages are also numbered consecutively. In the receipt of a group of figures, the two last figures (or the units and tens as they would appear in numeration) represent the line, whilst the other figure or figures represent the page; thus the group 11865 would signify page 118, line 65, of Part 4. The group 1866 would signify page 18, line 66, of part 3; and the group 866 would signify page 8, line 66, of part 2. In the event of only one figure, or a group of two figures only, being received, it is known to have reference to the corresponding lines in the blank page of the code, or that portion of it providing for the letters of the alphabet and particular signals classed as Part 1, whereas the rendering of a message from code into ordinary language is particularly easy, as just demonstrated. The rendering of a message from the ordinary language into code is equally easy, inasmuch as the vocabulary and sentence part (Part 4) is arranged alphabetically, and therefore any word or part of a sentence is as easily found as is any word in an ordinary dictionary, and its page and line instantly ascertained. Thus the message, "As soon as convenient," will be found under the word "convenient" in the code book, which, being numerically paged and lined, may be described for illustration as at page 116, line 78, or, as it would appear, in group 116,78.

By the foregoing explanation of the component parts of this code, it will be observed that the means have been furnished to express by

Part 1. The letters of the alphabet, particular telegraph signals, and the like.

Part. 2. A ready means of spelling any word in any language having English characters.

Part 3. Sentences pertaining to commercial and political intelligence, and the names of the principal places in the world.

Part 4. Every word in the English language, together with several thousand sentences likely to form the subject of telegraphic messages.

Part 5. The name of every known place in the world, an abstract of which is in Part 4.

This system is applicable to all long telegraphic lines, but especially to submarine lines, and by its adoption the working power of transmission over the ordinary system is considerably increased. Blank spaces may be left at intervals in the numbers of the code, which may be filled up from time to time by inserting such other sentences as may be found convenient and useful.

It is evident, from what has been said, that although, by way of example, a method is here described of constructing and using or referring to a code which is based upon numbers, yet a system essentially the same in principle could be framed and employed, having letters or a combination of letters and numbers for its basis. Thus, for example, in such cases, when letters are employed, the pages of the book containing the code might be designated alphabetically, or by a series of letters alphabetically or otherwise arranged; and the last two letters of a group indicated by telegraphic means may refer to the line, whilst the other letter or letters refer to the page, where the message or part thereof intended to be transmitted will be found. Where only one or two letters are indicated by the telegraphic instrument, a certain special page of the code will be understood to be referred to, and the letters will point out the line on that particular page where the meaning of the signal is expressed. In order to facilitate the finding of a specified line, a movable graduated scale is employed, divided in such a manner that the numerals or other indications placed thereon, when placed parallel to the column of printed matter and properly adjusted thereto, shall correspond to the lines or rows of printed matter contained in each page or part thereof. It will be readily understood, that in such codes or other printed matter as shall have numerals or other indications opposite to or incorporated with such printed rows or lines, that the use of the scales as before mentioned will be unnecessary.

SECURING CORKS AND STOPPERS.

J. H. Johnson, *London and Glasgow.—Communicated by* Arthur Barbarin, *New Orleans, U.S., A.—Patent dated 3rd Aug.*, 1866.

This invention consists, firstly, in the employment of a disc of elastic india-rubber, having its border turned over and made thicker than the middle portion of the disc. When the cork or stopper is in its place, one of these discs is stretched across it, and its border is then passed over the flange or projection at the mouth of the bottle or jar. The

Fig. 1.

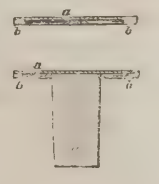
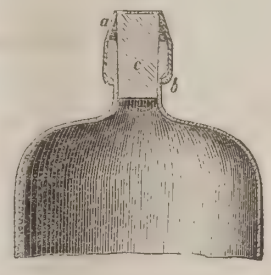


Fig. 3.

Fig. 2.



thickened border of the disc will, if a disc of suitable size has been selected, nip the neck of the vessel below the flange, and the cork or stopper will thereby be firmly retained in its place. The stopper may itself be formed of india-rubber, and if thought desirable, the disc may be cemented by any suitable cement to that stopper. The disc may also be stretched across the mouth of a vessel in the absence of a cork or stopper, and will thus form a useful temporary stopper or cover. Another part of this invention consists in the employment of an elastic ring of india-rubber having one or more strips or bands of the same

Fig. 4.

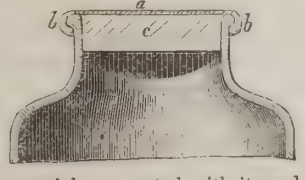
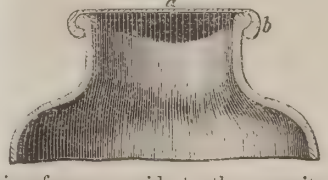


Fig. 5.



material connected with it, and passing from one side to the opposite side. The ring being slipped over the flange on the neck of the vessel, as before-mentioned, the cross strips or bands will necessarily pass over the cork or stopper, and retain it in its place.

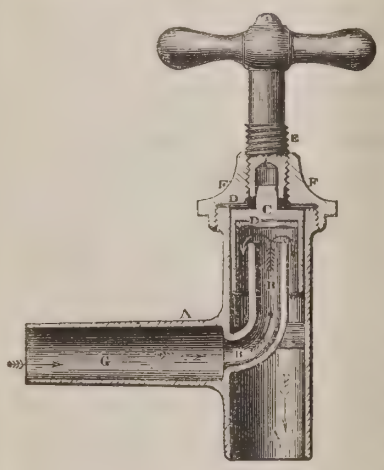
Fig. 1 of the engravings is a section of the rubber holder first above-mentioned. *a* is a disc of thin rubber, around the outer edge of which is a ring, *b*, of thicker rubber, which should be smaller than the neck of the bottle to be corked. When the device is put in use, the cork, *c*, fig. 2, is first inserted in the neck of the bottle; the disc, *a*, is then placed on the top of the cork, and its edges drawn down, until the ring, *b*, is secured under the flange on the neck, which it pinches firmly. The cork may either be separate from the fastening device, or, which is perhaps preferable, it may be secured to the disc, so that all the parts shall form one device, as shown in section in fig. 3. Figs. 4 and 5

show the manner in which the rubber discs or rings shown in fig 1, may be applied to an ordinary glass jar. The disc may be used either in connection with a cork, as shown in fig. 4, or without a cork, as seen in fig. 5. To apply the device to the jar, the elastic disc, *a*, is stretched tightly over the mouth of the jar, and at the same time it is drawn down until the outer rubber ring or clasp, *b*, catches under the flange on the neck of the jar. Whether used with a cork or not, it will seal the jar so as to prevent all evaporation of its contents. If desired, the rubber disc may have more of a bag shape, and the ring, *b*, by which the device is secured in position, may be of any form, thickness, or size, or of equivalent elastic material.

TAPS OR COCKS.

J. H. Johnson, *London and Glasgow.—Communicated by* William Moodie, *Montreal.—Patent dated 26th September*, 1866.

This invention relates to an improved and simplified construction of tap or cock, suitable for regulating or controlling the flow of water and other fluids, and consists essentially in providing the body of the tap with an internal tube, opening into a chamber also formed on the body of the tap. This chamber has a screwed cap fitted thereon, through the centre of which passes a screwed spindle, provided with the usual handle, which spindle acts upon a cap or valve under the chamber, and causes it to close down upon the mouth or end of the internal tube in the chamber. When the tap is intended for low pressure, the cap or valve should be connected to the screw spindle, so as to enable it to be raised when turning on the water; but if high-pressure service be employed, then the cap or valve need not be coupled to the screw spindle, as the pressure of the water will be sufficient to elevate the valve when released from the pressure of the screw spindle. If desired, a packing consisting of a disc or washer of leather, india-rubber, or other suitable material, may be inserted in the cap or valve, or the metal surfaces of the valve and the end of the internal tube may be ground together and used without packing. The chamber in which the internal tube enters is in communication with the discharge end of the tap, or may itself form the discharging nozzle, whilst the internal tube communicates only with the inlet end of the tap, so that on opening the valve by unscrewing the screw spindle, a free passage of the liquid takes place through the internal tube, and thence through the chamber to the discharge nozzle.



The accompanying engraving represents a sectional elevation of the improved tap. A is the body of the tap, which may be constructed of any suitable shape or material; B is an inside tube made to form a part of the tap itself, or to be added to it afterwards; C is a cap or valve with or without a cushion or washer, D, of leather, india-rubber, or any other suitable material, and attached to a screw, E, working through the collar, F, which is tightly screwed down, or otherwise securely fastened to the neck of the tap. It is well-known that taps or cocks, after having been for some time in use, and subjected to heavy pressure, become worn and defective, and allow the water, steam, or other fluid to escape, in consequence of the imperfect fitting of its parts from wear. By means of this invention, all leakage from this and other causes is prevented in the simplest and most effectual manner. The mode of operation is as follows: the fluid enters in the direction of the arrow at G, and passes along the body of the tap, A, and up the tube, B. If it be desired to allow the fluid to escape, the cap or valve, C, is raised by turning the screw, E, thus leaving the requisite opening for the fluid to pass. To close the tap, the cap or valve, C, is lowered down on to the top of the tube, B, upon which it may be pressed with the requisite degree of force by means of the screw, E, and thus prevent the escape of any fluid confined inside. The screw, E, may or may not be attached to the cap or valve, C, according as there is pressure or not, or as may be found advisable. The superiority of this over every other tap, consists in its great simplicity, at the same time it being almost impossible to get it out of repair. When once fitted up, a plumber will not be afterwards required, thereby saving a considerable expense and annoyance. Should it at any time leak, it will be simply necessary to unscrew the top, lift out the cap or valve, C, and insert a new leather washer, which any person may do. These taps are particularly well adapted for high-pressure service.

HEATING PERMANENT INFLAMMABLE GAS.

B. F. Stevens, *Covent Garden, London.—Patent dated 15th June*, 1866.

This invention has for its object the obtaining of a greater degree of heat from the burning of coal gas, or other permanent inflammable gas produced by the distillation of wood, rosin, petroleum, peat, or other hydrocarbon substances or equivalents, whereby they are rendered more suitable as fuel for manufacturing and domestic purposes, and for the generation of steam, and it consists essentially in mixing steam with the said gas in the manner hereinafter described, and employing this mixture for the production of heat. In carrying out this invention the ordinary arrangement of furnaces provided with tubes, burners, and other appliances heretofore employed for burning gas may be used, but with the addition of pipes for the purpose of mixing steam with the gas just previous to its reaching the burner or burners. By thus mixing steam with the gas jet just before it is burnt, the character of the flame is changed and its volume greatly increased, so that when applied, for example, to heating steam generators, it will entirely fill the spaces under the boiler and between the tubes. In lieu of passing the steam jet directly into the gas pipe or pipes as they approach the burner, the steam jet *may be arranged so as* to cause an increased draught of air to act upon the flame, and the mixture of gas and steam may be used either alone, as gas is commonly used, or it may be employed to aid in the combustion of ordinary solid fuel. The steam for admixture with the gas may be generated in a boiler heated either by the flame produced by the burning of such mixture itself, or by a separate fire. In some cases, such, for example, as the heating of buildings, heating of metals, roasting ores and the like, the steam generator for supplying the steam for admixture with the gas may form part of the fire-box or furnace in which such mixture is to be burnt. By heating either lime or platina sponge or wire to an intense white heat, by means of the mixture of steam and gas, a light suitable for illuminating purposes may be obtained.

GRATE BARS FOR FURNACES AND FIRE-PLACES.

J. H. Johnson, *London and Glasgow.—Communicated by* William M'Monnies, *New York.—Patent dated 24th July*, 1866.

The said invention relates to a peculiar construction of grate bars, for furnaces and fire-places, and has for its object the keeping of the material of the said bars cool, by increasing the surfaces of the bar acted upon by the currents of cold air nearly two-fold, without increasing the area of metal in contact with the fuel, and furnishing air to the fuel at a higher temperature than is furnished by other bars, which is effected by leading currents of air through a deep and narrow channel extending along the under side of each bar, by which means the heat is taken up from the metal and imparted to the air, its rarefaction thereby accelerating the passage through the fuel; hence, by a larger quantity of heated air reaching the fuel, economy is effected.

According to this invention the top of the grate bar is solid and of any desired form on the surface, but it has two thin and deep webs formed on the under surface, extending throughout the entire length of the bar, and having an air space between them, such air space being closed at the upper part by the top of the grate bar, and left open to the ashpit along the whole length of the bar on its under side. A series of holes are made through both these thin webs, communicating with the upper part of the air space between them, and these holes are so placed as not to come opposite each other, but to break joint so that the heated currents of air will not oppose each other in their escape from the interior of the bars. The heat communicated to the upper edge of each bar is conducted downwards through the material composing the two vertical sides or thin webs, and is carried off by the

ascending air, which passes up through the interior space between the webs and escapes through the lateral apertures above referred to. In lieu of the heat being brought in contact with the cold air on the two sides and narrow lower edge only of the grate bars, as in ordinary bars, to radiate or conduct the heat to such air, this invention presents the additional surface of the whole inner faces of the two webs or sides, as well as the surface round the lateral apertures, whereby the bars are

Fig. 1

more effectually and rapidly cooled, whilst the temperature of the air on its way to the fuel is greatly augmented. In other words, the currents of air received in the bottom of each grate bar, and discharged through

Fig. 3. Fig. 2.

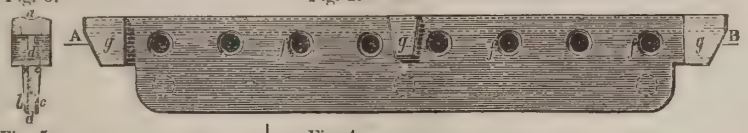
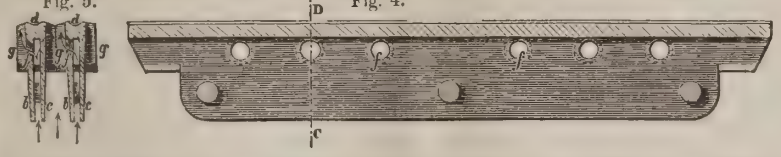


Fig. 5. Fig. 4.



the lateral perforations in the webs or sides, cool the bar, in addition to the ordinary currents which flow up past each side of, or between, the bars.

Fig. 1 of the engravings represents a longitudinal section of the bar, taken at A B, fig. 2, through the centres of the holes, *ff*; fig. 2 is a side view; fig. 3, an end view; fig. 4 is a longitudinal section; and fig. 5, a section of two bars taken at C D.

d is the top or main upper surface in contact with the fuel, made, as usual, slightly hollow to retain ashes; and *b* and *c* are thin portions forming sides, leaving the channel, *d*, entirely open at the bottom and ends, and running the whole length of the bar; *ff* are holes communicating from the upper part of the channel, *d*, to the exterior of the bar on each side; these holes are not placed directly opposite each other, but are *staggered* so that the escaping currents of heated air do not oppose each other. The heat communicated to the top surface of each bar is conducted downwards, or diffused through the material of the vertical sides, *b* and *c*, and is carried off by the ascending air which passes through the channel, *d*, and escapes through the holes, *ff*. In addition to the surface of the two sides and narrow lower edges, as in ordinary bars, to radiate or distribute the heat to the air, this invention presents the additional surface of the whole inner faces of the sides, *b* and *c*; thus more effectually and rapidly cooling the bar and preventing its speedy burning or warping, while giving air to the fuel in a much more heated state, and in a larger quantity. The top of the bar being wider than any other transverse portion of it, permits the free descent of the fuel or ashes between the bars, and prevents any portion of the heated fuel or residuum from resting or remaining upon the sides or any part of the bar other than the narrow top, *a*, and as a consequence preventing the choking or clogging of the transverse holes, *ff*, in the sides, *b* and *c*, of the bar, thereby securing at all times an unobstructed passage for the heated air as it escapes from the channel, *d*.

These bars are placed in furnaces in the same manner as ordinary bars, and are equally as convenient to "prick" or "slice" in order to clean the fires or remove the clinkers; they are lighter than bars ordinarily used, and more convenient to remove, replace, and clean.

ORNAMENTING KAMPAKAON, LINOLEUM, KAMPTULICON, AND ENAMELLED INDIA-RUBBER FLOOR CLOTHS.

JOHN LONGBOTTOM, *Leeds.—Patent dated 22nd August*, 1866.

THIS invention relates to new or improved methods of ornamenting various articles known under the name of Linoleum, Kamptulicon, Kampakaon (which is any article made from peat turf or fibrous bog soil with the aid of some adhesive or binding material), Enamelled India-rubber Floor Cloths, and other similar articles. One method consists in the application of small fibres specially prepared for the purpose from old or waste silk, woollen, worsted, or cotton goods, including cloths and listings, and also hair or down, and the blowings or material resulting from the tearing of woollen goods, and using also minerals in their natural state or calcined and ground fine, and metal-bronze and vegetable colours. The flockings of fibrous materials above referred to may be prepared for the intended purpose by the use of spiral knives fixed on rollers or cylinders named "Lewis' Cropping Machines," or spiral "Perpetual Machines," or by other suitable machines. It is also proposed to use minerals in their natural state or calcined and reduced to a fine state of division, also metal-bronze and vegetable colours, for ornamenting the said goods. The article to be ornamented is to be smeared or stamped with an adhesive material formed from the combination of india-rubber, coal tar, and shell-lac, or with any other suitable adhesive matter, and the before-mentioned materials reduced to a state of fine division are then applied to the articles to be ornamented, either by passing such articles through a quantity of the same, or by any other suitable mode of application. The Kampakaon, Linoleum, or other article, will thus receive a certain amount of the fine *fibrous materials*, which will firmly adhere thereto when the adhesive compound has dried. If the adhesive material is applied so as to form patterns, a great variety of ornamental designs may be given to the articles before mentioned. Another mode of ornamenting these articles is by cutting silk, woollen, cotton, or other fabrics into patterns, then smearing one side of such patterns with the adhesive material and finally applying them to the articles to be ornamented. In other cases it is proposed to mix the *material to be applied when in a state of fine division* with the adhesive material, and then apply the mixture to the article to be ornamented. In most cases it is preferred to pass the article between rollers after it has been treated by any of the methods before described, so as to facilitate the adhesion and give a better appearance to the finished goods.

LAW REPORTS.

SHEEP DIPPING COMPOSITIONS — INFRINGEMENT — ALEX. M'DOUGALL *v.* ROBERT GIRDWOOD.—This was an action tried before the Lord President of the Court of Session in Scotland and a jury, in Edinburgh, on the 8th, 9th, and 10th April, 1867, for an alleged infringement of the letters patent granted to Mr. M'Dougall in 1860 for improvements in materials for destroying vermin on sheep and other animals, and for protecting them therefrom. The plaintiff, Mr. M'Dougall, is the well-known manufacturing chemist of Manchester, and the defendant, Mr. Girdwood, is a wool broker in Edinburgh. The infringement complained of was the manufacture and sale by Girdwood of a sheep-dipping composition called "Girdwood's Improved Melossoon or Sheep-protecting Dip."

Mr. Geo. Young, Mr. Mackenzie, and Mr. Balfour, instructed by Messrs. Macnaughton & Finlay, W.S., were counsel for the plaintiff or pursuer; and Mr. A. R. Clarke, Mr. Watson, and Mr. Vasy Campbell, instructed by Mr. Andrew Webster, S.S.C., were counsel for the defender.

As the shorthand notes of the report fill sixty-eight pages the same size as our Journal's pages, it is impossible to give more than a brief abstract of the proceedings. The case, like most other patent cases, depended principally on the evidence of scientific and practical witnesses; the chemists examined on behalf of the plaintiff being Dr. Odling, F.R.S., Dr. W. A. Miller, F.R.S., Professor Penny, F.R.S.E. (Glasgow), and Dr. Stevenson Macadam (Edinburgh); whilst Dr. Henry Letheby, professor of chemistry, London Hospital, was the only scientific witness for the defence.

From the proceedings it appeared that Mr. M'Dougall in his specification stated that his invention consists in the use of the heavy oil of tar, or dead oil, or crude carbolic acid, as it is sometimes called, or creosote, obtained in the destructive distillation of carbonaceous substances. These materials he treated with an alkali, and added a saponifiable fatty substance. In 1864 an action was brought by Mr. M'Dougall against the trustees of the Edinburgh New Veterinary College and Professor Gamgee and Mr. Girdwood, complaining of an infringement of his patent by the manufacture and sale of a dip called "Girdwood's Melossoon or Sheep-protecting Dip," which action was compromised by agreement in July, 1865. By one of the heads of agreement, Girdwood and the other parties bound themselves that they would not infringe the said patent by manufacturing and vending "Girdwood's Melossoon or Sheep-protecting Dip," or use any substance whatever made or manufactured in the manner described in the said specification, and that they would not infringe or contravene the said patent in any other manner. Since January, 1866, Girdwood had infringed M'Dougall's patent by manufacturing "Girdwood's Improved Melossoon or Sheep-protecting Dip," which contained the materials mentioned in M'Dougall's specification. It was also alleged by the plaintiff that the process of manufacture followed by Girdwood was the same or substantially the same as that described in M'Dougall's specification; that the said manufacture was in direct violation of the said agreement, and that the "Improved" was substantially the same with the "Melossoon Dip" mentioned in the agreement, with the addition of hellebore.

Mr. Girdwood, in his defence, admitted the manufacture of the "Improved

Melossoon," but denied that it was the same with M'Dougall's invention, and he explained that in his manufacture he used "light pitch oil, having a less specific gravity and a lower boiling point than water, and also vegetable poisons; heavy oil of tar, or dead oil, or crude carbolic acid, or creosote, being carefully excluded, as being injurious to the wool." He also denied that the process followed by him in his manufacture was the same as that of M'Dougall.

With the view of trying the question the following issues were agreed upon:—

"1. Whether, between 28th January and 17th May, 1866, the defender did, within or near his premises at Tanfield, near Edinburgh, wrongfully, and in contravention of the said letters patent, use the invention described in the said specification, as altered as aforesaid?

"2. Whether, between 28th January and 17th May, 1866, the defender did wrongfully, and in contravention of the said letters patent, vend a material or composition for destroying vermin on sheep and other animals, and for protecting them therefrom, manufactured by the use of the invention described in the said specification, as altered as aforesaid?"

Mr. George Young opened the case for the plaintiff, and Mr. Watson for the defendant. The case was ably argued on both sides, and was carefully summed up by the Lord President in his charge to the jury, which we give fully, as it explains the whole case. He said—I have no doubt that this is a case of very considerable importance to the parties, and it appears to me to involve a question of very considerable difficulty—a question which, I may tell you at the outset, will, I think, depend for its solution very much upon the view that you may take of the evidence. In many patent cases there are so many points of law involved, that although they are said to be tried by a jury, they come to depend practically upon the view that the court may take of the construction of the patent, or of some other point of law involved. But this is eminently a case of an opposite description, in my opinion, and I mention that to you at the outset, because it is a reason for my inviting your most serious attention to the observations which I am going to make to you, that you may thoroughly understand the question in fact which you have to solve. And in order to eliminate that question as clearly as I can, I will tell you some things that you are to take for granted in point of law, and about which, indeed, there is no dispute at all. In the next place, I beg you to understand that there is no question here as to the validity of this patent. It is unquestionably a good patent, perfectly regular and valid, and granted for a proper invention, such as may legally form the subject-matter of a patent. Further, it is not in dispute that Mr. M'Dougall, the patentee, is the first and true inventor of the invention for which the patent was granted; and lastly, it is further admitted that his invention is one of practical utility and public benefit, which is, among other things, necessary to give validity and effect to any patent. Now these things being premised, you will at once understand that the question between the parties is narrowed to this—Whether the defender, Mr. Girdwood, in what he has done, has invaded the right of the patentee, secured to him by his crown grant? Be kind enough to look at the issue before you, and you will see still more distinctly that that is the true and the only question that is put to you. In one word, the question is this—Whether the defender, Mr. Girdwood, has manufactured and sold a composition the same as that for which Mr. M'Dougall has obtained his patent? Now, gentlemen, it is necessary still further, in directing your attention to the evidence, that you should keep in view what it is that Mr. M'Dougall has obtained a patent for, what is his invention, and that he has described himself quite distinctly upon the face of the specification. I shall state it to you in a very few words. His invention consists in the use of a certain oil—we shall see by-and-bye upon the evidence what that oil is—it consists in the use of a certain oil which he treats with an alkali, or, in other words, renders mixable with water by means of an alkali, and to which he adds a fatty substance capable of being converted into soap, the effect of all which is that he thereby produces a substance of the consistency of a soft paste, which is to be used as a soap in the washing of the fleeces of the sheep. Now this, you will observe, is an invention of a product or composition. The thing which he claims as his patent is the result of this combination. The materials which he uses are all perfectly well known materials; the oil, the alkali, and the fatty or saponifiable substance, as it is called, are all things perfectly well known, and the use of which is open to everybody; but the merit of his invention, and the invention itself, consists of this, that he combines them in such a way as to make them practically useful in destroying the vermin upon the sheep. Be kind enough to keep in mind, therefore, that this is not an invention of a process of manufacture; it is not a patent for a mode or method of doing a thing; and just as little is it a patent for a discovery, if that were in any proper sense the subject-matter of a patent. There is no doubt that there is a discovery, as Mr. M'Dougall told you, lying at the foundation of this invention, because he discovered that this oil was a substance capable of being used for destroying the life of that kind of vermin which infests the fleeces of sheep. That was his discovery, and upon that discovery he bases his invention. But the discovery is not the invention. The invention is the combination of those materials that I have already mentioned—the oil and the alkali, and the soapy substance—to produce a dip or paste with which you may wash the sheep and remove the vermin. Now, gentlemen, that being so, I am asked to tell you with regard to the oil which he has specified in this specification, that it will not embrace any oil that is not of a greater specific gravity than water, and I am asked to tell you that as matter of law, upon the construction of this specification, independent of the evidence altogether. Now, I can't tell you that, because I think that is not good law, and I think that is not the true legal construction of this specification; and I am very glad that I am not in a condition to tell you that, because the effect of it would be to take the decision of this case out of your hands, and I am much better pleased to leave it in your hands. I shall now proceed, therefore, to tell you what is the view of the evidence upon this matter, and how the evidence applies to this question. Everything depends upon the meaning of the terms which are used by Mr. M'Dougall in his specification. If he has used terms which mean this, that he claims no composition except that in which the oil shall necessarily be of a higher specific gravity than water, then Mr. Girdwood says with great force, "I don't use such an oil—I use a different oil." But if, on the other hand, Mr. M'Dougall has used terms which will embrace not only oils that are of a higher specific gravity than water, but also oils that are of a lower specific gravity than water, then Mr. Girdwood's plea is not good. It depends therefore entirely, you will observe, upon what is the meaning of the words that the patentee has used in describing the oil which enters into the composition of his dip. And the meaning of these words is not matter of law. If it had been matter of law, I should not have allowed any evidence to be led upon the subject. But on the contrary, these words are words either of a chemical or of a commercial meaning, and that forms the proper subject of evidence, to ascertain what is their true meaning, either chemical or commercial. Now, gentlemen, in order to make the point between the parties still more clear, just let us see what it is that Mr. Girdwood says he has done. He proposes to make this composition in the month of January, 1866, and upon the 10th of that month he writes a letter to Forsyth & Co., the tar distillers in Leith, in these terms:—"Will you be so good as send me a twenty gal. cask or so of light pitch oil. I must have it free of the dead or heavy oil, or I cannot use it. See that this is most carefully attended to, and if I find it all right and suitable, I may drive a trade in it; but any departure from the light oil towards heavy will be a complete stopper. Send it as soon as you can, and oblige, yours faithfully—(Signed) ROBERT GIRDWOOD." Then there is a postcript, "The above is for experiment, so see that it is such as I can get regularly, and as wanted, free from heavy oil." Now, in his evidence Mr. Girdwood says that he got the "light pitch oil in its natural state, so far as I know, without any of the carbolic acid being taken out of it. I used no means to take any carbolic acid out of it. I would not use the heavy pitch oil; it is too thick, and of too pitchy a nature. M'Dougall's dip when dissolved in water is very much thicker than mine. I also prefer the light oil, because there is no danger of it staining the wool." And then at another place he says, "I cautioned Forsyth to be sure to send the lightest oil they could, and not to send any that was heavier than water. My object was to be sure that the dip would not stain the wool. There were complaints of the dip made by the Veterinary College staining the wool. I did not try by experiment whether the Veterinary College's dip stained the wool or no." Now, gentlemen, there is no attempt made to show that there is that distinction between the heavy oil and the light oil as regards its effects upon the wool, and we should certainly have had evidence upon it if it had been possible to prove it. Therefore that reason for adopting the one kind of oil rather than the other is not a very satisfactory one, and I rather think Mr. Girdwood gave the truer reason when he said in another place, "I ordered the light oil because I did not wish to infringe the pursuer's patent;" or, in other words, "I wanted to make a dip that should be as good as the pursuer's dip at least, without coming within the letters of his patent;" and I must tell you, gentlemen, that that is perfectly legitimate. A patentee enjoys a monopoly, and everybody that can bring himself without the line and letter of the monopoly is entitled to do so. And the monopoly, or, in other words, the patent, is not to be construed so as to stretch it beyond its due construction, for the mere purpose of saving the patentee's rights. But, on the other hand, it is also just as true, in point of law, that a patentee is entitled to claim for his specification a fair and reasonable construction. The general public are entitled, as much as they can, to free themselves from the effects of the monopoly, and to endeavour, by invention in every other way, to do without the patent, and so to escape from the effects of the monopoly, and it will always be just a question whether they have succeeded in getting without the line of the patent, or have trespassed within it. Mr. M'Dougall's composition for the destroying of vermin in sheep may be, and I have not the least doubt is, a most valuable composition, and highly useful to the sheep farmers of this country; but although he is entitled to be protected in the manufacture and sale of that particular composition which he has made, and which he has specified, everybody else is just as well entitled to try and make a better composition, or as good a composition, provided they don't come substantially within the description of his composition, for which he has obtained his patent. Now the oil which Mr. Girdwood obtained from Forsyth and Company was subjected to analysis. There was a specimen of it put into the hands of Professor Penny, and we got the result of his analysis this morning, which may be very shortly stated. He says, "I found it to correspond in its properties, specific gravity, boiling point, and composition, with what is called light pitch oil; that is, the first runnings of the dead oil. The specific gravity was 961°. Of acids I found 24 per cent.; of bases 10 per cent.; and of neutral substances 66 per cent. The acids, bases, and neutrals are the acids, bases, and neutrals of dead oil. Carbolic acid is the leading acid, just as I should expect in the first runnings of dead oil. It was all there, none washed out. The carbolic acid is not injurious to the wool. It is the most potent agent in the destruction of insects. When the dead oil is separated into parts, there would be, on an average of specimens, 15 per cent. of acids, 17 per cent. of bases, and 68 per cent of neutrals; but it is a very variable substance in its composition." Now, gentlemen, you will observe that it is proved by this evidence undoubtedly that the specific gravity of the oil which is used by Mr. Girdwood is under that of water. It is 39° out of 1000 lighter than water. It is proved further to consist of the same constituents as dead oil in the largest sense of the term, that is to say, the whole product of the distillation of coal-tar between the naphtha at the first end of the distillation, and the pitch at the other end, which is the residuum. No doubt the proportions are different, but the constituents are of the same nature. They are acids, and bases, and neutral substances generally of the same character. Now, keeping these things in view, the next question for your consideration is this—and it is the last and the great question in the case—What is, according to your view of the evidence, the meaning of the words which I am now about to read to you, "heavy oil of tar, or dead oil, or crude carbolic acid, as it is sometimes called, or creosote, obtained in the destructive distillation of carbonaceous substances?" Do these words, according to the evidence before you, fairly include the oil used by Mr. Girdwood, and analyzed by Professor Penny yesterday. That is the question for your consideration. Now, gentlemen, I am not going to trouble you by reading over my notes of the evidence, because I am quite sure your minds are already very sufficiently filled with a knowledge of the details of that evidence, but I shall take the liberty of making one or two observations on the general import and effect of it. In the process of distillation of coal-tar, you have been told that the lightest substances always come off the first, and there is a regular succession of substances in the precise order of their weight. Now, it would be quite easy, of course, to divide the products of this distillation in a hundred different

ways, according to the fancy or the profit of the distiller. You may divide it into any number of portions you like. You may take the first portion off as crude naphtha; you may take the second portion off as all below a certain specific gravity, taking a very low point; and you may go on taking another portion at every 50 degrees of specific gravity as you rise. All that is quite possible. But there is certainly one very marked distinction between at least two portions of the products of the distillation, I mean besides the residuum of pitch—and that is the crude naphtha which comes away in a perfectly distinguishable state, and is accompanied, as one of the gentlemen told us, by an ammoniacal liquor, which comes away at the same time. There is a marked distinction between that and the general body of the oil. But then, in practice, certainly in a number of the works of tar-distillers—that is beyond all question on the evidence—there is a portion of the products of distillation immediately succeeding the crude naphtha, but all under the specific gravity of water, that is taken off separately, and dealt with as a separate commodity, and which, in some of these establishments, is known and sold as "light pitch oil." I think all that is quite true upon the evidence; and the difference between that light pitch oil, and the remainder of the pitch oil, appears to be this, that, as it comes off earlier, it is composed of the lighter hydrocarbons, as they are called, the heavier hydrocarbons remaining behind, and requiring greater heat to run them off; and this light pitch oil is found also to contain a certain portion of naphtha, the whole of the naphtha not having gone off in what has been already separated as the crude naphtha. Now it must be perfectly obvious, after the evidence that we have heard, that the value of these different commercial articles is very different. Naphtha is very much more valuable than the rest; but the light oil, that is to say the pitch oil which is under the specific gravity of water, not only contains some portion of naphtha, which would make it more valuable, but also the lighter hydrocarbons generally, which are more valuable than the heavier, and so it bears a higher price, and is sold for 5d. a gallon as compared with 2d. and 3d. a gallon, which is the price of the heavier oil. Now, gentlemen, that suggests to one that it may have been in the mind of the patentee, probably enough, to take as the ingredient in his composition the cheaper article, if it was as efficacious. That is a thing that is naturally suggested by the evidence. Of course, if in making this composition for washing sheep, you find that the heavier hydrocarbons, or whatever else may be in the oil that is valuable—that those parts of it that come off the last and are the cheapest in price, are as efficacious in killing the vermin as those that come off first, you will naturally take those that come off last; and that would make it very natural for the patentee to suggest that you should take the heavier part of the oil, because you thereby make your composition cheaper. Now, that seems to me to tell in two ways upon the question that is before you. If, proceeding upon that idea, the patentee has so incautiously expressed himself that he has limited himself entirely to the use of that heavy and cheap oil, and not made his patent applicable to a composition into which the lighter and dearer oil may enter, then I am afraid he has committed a great error; but if, on the other hand, you can so read the terms that I have laid before you as to understand them as suggesting merely that the oil of tar is the substance with which he means to deal, and that he suggests that the heavier portion of it may be used as equally efficacious with the lighter, then his patent will read quite consistently, and in such a way as to cover the oil used by Mr. Girdwood. But all that is for you. It is a matter entirely for your consideration on the evidence, which is the fair way of reading these words. Now, I shall read them to you once more, that you may be quite sure that you know what you have to deal with. They are, "the heavy oil of tar, or dead oil, or crude carbolic acid, as it is sometimes called, or creosote, obtained in the destructive distillation of carbonaceous substances." Now, gentlemen, I hope I have made the question which is left in your hands sufficiently clear. I cannot say that I can present it to you as a question free from difficulty. On the contrary, I am quite sure you yourselves must feel that it is attended with a great deal of difficulty upon the evidence; but I don't think I could consistently with my duty, and without usurping your province, attempt to aid you further in the solution of that question; and I must therefore now leave it in your hands, and I beg you to give your best consideration to it, and to return your verdict as soon as you are ready.

The jury found a verdict for the pursuer by a majority of nine to three.

REVIEWS OF NEW BOOKS.

PARKYN JEFFCOCK, Civil and Mining Engineer: a Memoir. By his brother, JOHN THOMAS JEFFCOCK, M.A. London: Bemrose & Lothian. Pp. 130.

AN interesting and affectionate memoir of a man who died in the exercise of his calling as a colliery engineer. Mr. Parkyn Jeffcock was an example of a class of men by no means rare in the northern counties; whose name, however, would probably have never been very famous beyond his own locality but for his melancholy death at the Oaks Colliery. This book, written by a brother, gives a faithful account of a life well-spent in the practice of his profession, not fraught with particular interest except to the personal friends of Mr. Jeffcock. Although the circumstances connected with the death of this young engineer (he was only thirty-seven years of age when he lost his life) are already well known, the collection of them in this memoir will be appreciated by many of our readers, and particularly by those interested in colliery working and management. The book is illustrated by a portrait of Mr. Jeffcock, a view of his residence, a plan of the Wharncliffe Silkstone Colliery, and a sketch plan of the Oaks Colliery, engine plans, and connections.

IRON; ITS HISTORY, PROPERTIES, AND PROCESSES OF MANUFACTURE. By WILLIAM FAIRBAIRN, C.E, LL.D., F.R.S., &c. Edinburgh: A. &. C. Black. Pp. 293. Litho. Plates and Woodcuts.

THE work before us consists in great part of the article "Iron," written some years ago by Mr. Fairbairn for the *Encyclopædia Brittanica*, and therefore must not be taken either as an exhaustive treatise, nor yet as a complete exposition by the author of a subject that he has the credit of being able to treat *en maître*.

So far as we can gather, there is nothing new advanced throughout the volume; the original work being, of course in this edition, brought down to the present state of metallurgic science.

The work contains a well produced paper on the Bessemer process, which we gather from the preface is contributed by Mr. Bessemer himself. This takes up sixty-four pages, and is probably the best written treatise on that revolutionizing branch of metallurgy that has yet appeared; it is, too, illustrated by a large number of exceedingly well executed woodcuts. No doubt it is intended by the author that the volume should form a handy book of reference; and as such it is well adapted to a place in the engineer's office library, who has occasion to consult more particularly the mechanical rather than the chemical properties and treatment of iron.

It is to be desired that the author would, rather than issue mere mediocre works like the present, and which certainly do not add to the repute which for other of his labours he has so justly earned, and such as other men of an inferior stamp could just as well have produced, and we think, too, it would be more creditable that a professional *premier* like the author, who is able to do it, should give to the world the benefit of his experience and views on a subject with which, beyond himself probably, no man amongst us has had a greater, more varied, or higher class of practice.—V. D.

FOREIGN LITERATURE.

HISTOIRE DES ECOLES IMPERIALES D'ARTS ET MÉTIERS—LIANCOURT, COMPIÈGNE, BEAUPRÉAU, CHALONS, ANGERS, AIX. Par A. GUETTIER. 1 vol. 8vo. Paris. 1865.

THIS volume by M. Guettier, well known as a writer upon iron founding, alloys, and various other technological subjects, ought to interest every one in England who feels in all the vast importance that belongs to it, the existing position of technical education, or rather of the total want of any such, in this country, and the momentous future that hangs upon that in the race of industrial competition with all the world, that is only now beginning to be felt by us as a nation to be really a race at all. For forty long years of peace we have had it nearly all our own way. The long wars that under Napoleon I. prostrated, by mutual injury, the whole of Europe, left us after Waterloo mistress of the situation: coal, the steam engine, the Indies, the carrying trade nearly of the world, vast growing colonies, Arkwright's and Crompton's inventions, the "gourd-like" development of the cotton, woollen, and flax trades, all were momentarily in our hands, and gave us a start in the race that has not been quite run out even now. Since that, steam ships, railways, gas, puddling, bar rolling, hot blast, free trade in corn and in other things, and the fiscal shackles in part knocked off from the paper-maker and the printer's arms, have helped to enable us to keep our position.

But with all this, and a great deal more that might be enlarged upon, *we have not relatively to Europe (and to America in a less degree) kept our industrial position.* The progress of the European nations has within the last fifty years been much greater relatively than our own. True, there was more room for progress with them than with us; but whilst at the end of the thirty years, Europe, weak and exhausted, drained of its wealth and of its manhood, rose up once more to rekindle its fires and handle the instruments of peace, and had everything to commence from the beginning, we stood robust, fed, and in full panoply, to strike into the combat of industrial contest. We have not kept the vantage then possessed; even now we hear complainings and misgivings as to "foreign competition," and see attempts, in great part false and self-interested, to throw the blame all upon the working classes, and upon trade unions, &c. In a word, Europe is now at our heels, if not even beside us, in the race; we have not maintained the distance, which is the same thing as to say we have lost ground. To us this is more ominous than to any other people upon earth. Greek power based

itself upon superior intellectual, social, and political wisdom, and upon freedom; Roman power was based upon the sword, simply and exclusively, as was also the vastest power of the middle ages, that of Carolus Magnus; but the power of Great Britain, since the Restoration at least, is based on industry, upon manufactures, trade, commerce, upon that which (whether we be called a nation of shopkeepers or not) is designed not to harass but to "alleviate man's estate," as Bacon nobly says, and which is therefore the truest and grandest foundation for empire that has yet appeared.

In such a contest as ours now has become for mastery in the world, not to win unmistakably, is to lose all and absolutely. Let us hear the oracle that really expresses the order in all things of the world we live in—"To him that hath shall be given, and from him that hath not shall be taken away even that he hath." *Absit omen;* the prospect is not pleasant, the prophecy is not of smooth things, the prophet therefore is not popular; but let us be wise while yet there is time, and endeavour to see how and by what means it is that Germany and France and Belgium, nay even Holland, Denmark, Sweden, and Russia, have been so swift in getting up to us in this industrial race. Like every great and widespread result, it is not attributable to any single cause; but amongst the several causes which have been most operative we fearlessly affirm, that superiority of education in the foremost nations of the Continent as compared with that of Great Britain, and as affecting every class, from the highest to the lowest, concerned with industry, has been the most effective and most widely operative.

The work at the head of this article refers to only a fragment of the grand machinery brought into play—and that in one country alone, France—for the promotion of technical education, within this century. France, amongst her other well-ordered apparatus for national education, possesses that of which we in England do not possess even the semblance, or any attempt at one; a great organization for technical education, not only of the high class of mechanicians, engineers, inventors, &c., but of every class of skilled workmen, and leaders of workmen (*contre-maîtres*).

She has at present six great schools, the localities of which are given at the head of this paper, wherein is systematically taught all that belongs to theory and practice in those arts of the mechanician, variously applied, which with us are learned, so far as they are learned at all, by the old worn-out, mediæval remnant of apprenticeships, a system but too often nothing more than an extra and not quite honest means to profit in the establishments that foster it, and are run after by ignorant parents and their inexperienced sons as roads to knowledge and avenues to future wealth, but which, in most cases, are but ways to ill-digested, ill-based, and imperfect knowledge, and to lowered morals and debased manners. These French schools of technology owe their origination in 1780 to the enlightenment and energy of a private individual, the Duc de Liancour, who founded the first upon his own estates. But their real development and bringing into a state of large and working activity was due to the sleepless activity and discerning genius of the great Napoleon, to whom (with all his ambition and faults due to it) France and Europe at large owe such immeasurable benefits. Since 1806, with some fluctuations in troublous times, as in 1830 and 1848, these schools, like all the rest of the educational machinery of Prussia, Belgium, and France, have grown and prospered more and more, and under the present emperor have received expansions greater than ever. They now possess iron foundries capable of making six or eight-ton castings, tool shops driven by steam power and filled with the best machine tools that can be produced. They execute actual work—engines, pumps, cranes, tools, divers' machinery and apparatus—for government and for the public, and are each supplied with a fine staff of competent professors of applied science, of technology, &c., all duly subordinated to and connected with the great national establishments for teaching the higher and abstract sciences, on the one hand, and with those for primary education on the other. These professors, with practical foremen in each department, who have themselves passed with honour their courses of instruction, are the governors and officers of these workshop universities, as we might call them. The establishments are therefore partly self-supporting, but their educational aspects and apparatus and staff are paid by the state. To these and to other like establishments is mainly owing the rapid and secure advancement of continental industry; to their effects is owing the fact that ought to startle us into action if anything can, that in all the branches of mechanism and of engineering that require the greatest skill and exactest knowledge, Germans and Frenchmen are now the successful competitors for employment in England, and in London itself, to the exclusion often of Englishmen, by English employers. To this is owing that our best electro-telegraphic engineers and mechanics are not Englishmen, but Germans; that the delicate contrivances, the brilliant invention of Wheatstone are carried out exclusively by M. Strohé, a German; that Messrs. Elliott's *ateliers*, celebrated for their well-known instruments of precision, are directed by Mr. Becker, a German; and that German and French draughtsmen, computers, artists in the offices of architects, mechanicians, and engineers, are preferred to Englishmen in our great manufacturing towns, such as Manchester, and London itself.

We cannot attempt here to unfold more of the system of technical education in full swing upon the Continent, while we in Great Britain possess nothing of the sort; though we doubt not "honourable members" and "noble lords" in plenty are to be found who fancy this is all fully and well done by the self-dubbed "Science and Art" department of South Kensington. But we commend the prompt and careful study of the subject at large, and, as a fragment of it, of this work of M. Guettier's, to every one interested in the manufacturing prosperity of our country.—Ed.

Der Telegraphenbau: Ein Handbuch zum Practischen Gebraucht für Telegraphen Techniker und Beamte. Von L. F. W. Rothes, Ingenieur, Telegraphen Inspector, &c. 1 vol. 8vo. (2nd edition), with illustrations. Berlin. 1867.

This is thoroughly a practical text or hand book for telegraph engineers, workmen of a higher class, and officers. It is not a big book, being only about 360 pages, not very closely printed, and with many interspersed woodcuts; but it has all the German character of beginning at the beginning about it, even to giving an account within the first ten pages of whence all the materials of electro-telegraphy are drawn, and devoting thirty pages to the description of all the different forms of insulators (on posts) employed in every part of the world almost. It deals with the abstract principles of electro-telegraphy only so far as is indispensable to the guidance in practice of the operator, while practical details are dealt with minutely.

It is thus a different character of work from that of Mr. R. Sabine, which has recently appeared in England; and were this of Herr Rothes in an English dress, they might advantageously supplement each other, but neither supersede the other.—Ed.

CORRESPONDENCE.

☞ We do not hold ourselves responsible for the views or statements of Correspondents.

LOCOMOTION IN THE ATMOSPHERE.

(To the Editor of the Practical Mechanic's Journal.)

Sir,—The question whether flight can be accomplished by means of the mechanical appliances at our disposal has of late forced itself upon the notice of the engineering world. Hitherto, however, it would appear that the number of attempts has been exactly equal to the number of failures. The balloon has been tried so frequently, and without success, that the whole subject has almost become a matter of ridicule and contempt. Many who have seen and read of the vain attempts to guide or steer this bubble, which when launched into the atmosphere becomes a part of it, have naturally turned their backs on the whole question, and some even refuse to listen to any reasoning whatsoever. But that need not be. A little arithmetic, combined with a spark of common sense, will show us that it is not to the balloon we should look if we wish to navigate the air, but to something much heavier, more compact, and substantial. As Dr. James Bell Pettigrew, in his lecture at the Royal Institute, London, on the 22nd ult., said, "If we are to accomplish flight, it must be by a body heavier than the atmosphere, one having 'weight, power, velocity, and small surfaces, *versus* buoyancy, debility, diminished speed, and extended surfaces,' weight in both cases being essential." I cannot agree with him, however, in mixing up the balloon with the body itself; for if a machine is to rise with such a cumbrous companion, yielding but the feeblest assistance, why not make the machine more powerful at once, so that it shall be able to raise itself, and without such extraneous aid. If we look at the bat, the bee, the butterfly, or better still, the bird, we find no indication of gas about them. Some have asserted that the bird inflates itself with hot air when about to rise, but this theory is now exploded, the very weight of the bird being one of the most essential conditions to its flight. Others again contend that the power put forth is far beyond the means at our disposal to imitate; but neither is that the case, for proportionately birds exert no more power in flying through the air than do animals running on the earth. We have surpassed these; why not the others also?

I hope, Sir, that the *Practical Mechanic's Journal*, which represents almost every department of physical and mechanical science, will lend its valuable assistance in

giving some little insight into the mechanical laws by which flight is accomplished; and as I understand attempts are being made by several to construct machines such as I refer to, let us give such enterprizing men a cordial welcome, and present them with every facility to crown with success their novel and arduous undertaking.

I inclose my card, and remain, Sir, yours, &c.,

A MEMBER OF THE AERONAUTICAL SOCIETY
April 12. OF GREAT BRITAIN.

[We shall be glad to open our pages for the discussion of this subject, and we may add that we hope in an issue or two hence to publish a paper that has long been promised us thereon by another "Member of the Aeronautical Society," whom we can testify as having paid unceasing attention thereto.—V. D.]

TREATING AND PURIFYING WATER.

(*To the Editor of the Practical Mechanic's Journal.*)

In Part XXV. (April 1st, 1867), of your Journal there appears an abstract of the specification of Mr. Robert Irvine's patent for "Treating and Purifying Water," dated August, 1866. The material which Mr. Irvine proposes to use for this purpose is the solid refuse of shale employed in the manufacture of paraffin oil. This is to be ground to powder, and a porous medium is thus to be formed which can be used as a filter for the purification of water. We beg to call attention to the fact that in *April*, 1861, *a patent was obtained by* Mr. Thomas Vaughan Morgan and Mr. Julius Gustav Dahlke, having the self-same object in view; and that the residue of the Torbane Hill mineral, or Boghead coal, has been used by us in the manufacture of the Silicated Carbon Filters since the above date.

In the *Journal of the Society of Arts* for 1861 there will be found a lecture by Mr. Dahlke fully explaining his process for the purification of water by this means, and showing how a combination of the *shale with animal charcoal* will effectually remove all colour and odour from water, at the same time considerably reducing its hardness. Even milky water is completely purified and rendered perfectly bright by these filters, a fact proved by the *Lancet* Commission upon Filters a short time back. We thoroughly agree with Mr. Irvine as to the capabilities of the material, but we deny altogether his claim to originality.

THE SILICATED CARBON FILTER COMPANY.
April 17, 1867.

[On referring to the *Patent List* for 1861 we find that Messrs. Morgan and Dahlke did *not* obtain a patent for their invention, but only a provisional protection for six months, which has long since expired. They were not, moreover, the originators of the idea of applying the coke of Torbane Hill mineral to the purification of water, as the specification of a prior patent granted to J. S. Herapath, of Bristol, No. 638 (1854), clearly sets forth the use of this material for the purpose referred to. We do not understand that Mr. Irvine claims to be the discoverer of the peculiar properties of the coke of Boghead coal; and he certainly does not mention that substance in his specification, which has reference only to shale. We have referred to the lecture mentioned by our correspondent, but cannot discover that Mr. Irvine's invention is therein disclosed.—Ed. *P. M. J.*]

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

THE INSTITUTION OF CIVIL ENGINEERS.

April 2, 1867.—The Paper read was "A Memoir on the River Tyne," by Mr. W. A. Brooks, M. Inst. C.E.

It contained a description of the tidal phenomena of the river, its condition previous to being placed, in 1842, under the charge of the author for its improvement, as contrasted with the phenomena which were found to exist after the completion of the river works. These works consisted mainly, in the first instance, of timber jetties, subsequently connected by river walls, formed of rubble mixed with ships' ballast, which was brought into the harbour and discharged into the line of the river works, affording an example of how much good might be effected in a port by the judicious application of available materials. The whole of the works on both sides of a navigation of 10 miles in length, forming what were locally called "The Tyne Improvement Works," were executed out of a revenue applicable to them, not amounting to more than £5000 a year, or to £80,000 spread over a period of about sixteen years. Northumberland Dock, inclosing a reclamation from the river of above 70 acres, and the Tyne Piers, had been, or were being executed, out of separate funds.

Much of the interest of the paper consisted of a dissertation upon the cause of the formation of Bars at the mouths of rivers, and the means available for their amelioration, according to the well-known theory of the author, that "Bars owe their existence to the confliction which takes place between the current of the early flood tide and that of the ebb, where shoals exist, preventing the free drainage of the backwater during the proper period of the discharge of the ebb."

The remainder of the Paper was devoted to the consideration of the effects which various forms, or alterations in the direction, of the piers at the mouth of the Tyne would have produced, as contrasted with the result of the piers planned by the author, which were already carried out to a considerable length.

It was announced that the discussion upon Mr. Brooks' Paper "On the River Tyne" would be resumed at the next meeting, Tuesday, 9th April, when, if time permitted, the following Paper would be read: "The Suez Canal," by Colonel Sir W. Denison, K.C.B., R.E., Assoc. Inst. C.E.

At the monthly ballot the following candidates were balloted for and duly elected:—As Members—Mr. Charles Napier Bell, Westminster; Mr. John Frederick Bourne, Inspector General of Railways and Colonial Railway Engineer for the Cape of Good Hope; Mr. John Edward Boyd, Engineer-in-chief of the European and North American Railway; Mr. William Dennis, Westminster; Mr. John Marley, Mining Offices, Darlington; Mr. William Martley, Locomotive Superintendent of the London, Chatham, and Dover Railway; Mr. Thomas Robert Shervinton, District Engineer, East Indian Railway; As Associates—Mr. Thomas Charles Clarke, Assistant Borough Engineer, Portsmouth; Mr. William Donaldson, M.A., Westminster; Mr. William Hartree, Greenwich; Mr. Henry George Hulbert, Bath; Mr. Thomas Jackson, Jun., Eltham; Mr. Edward Davis Mathews, Resident Engineer, Quebrada Mining Co., Tucacas, Venezuela; Mr. Henry Beadon Rotton, late in the service of the Government of New Zealand; Mr. Peter Thomson, Liverpool; Mr. Thomas Andrew Walker, Westminster; and Mr. John William Watson, Contractors' Staff, Ceylon Railway.

April 16, 1867.—The Paper read was on "The Suez Canal," by Colonel Sir W. Denison, K.C.B., R.E., Assoc. Inst. C.E.

It was stated that the scheme of the Suez Canal might be said to comprise two distinct undertakings. The first, and principal, was the construction and maintenance of a broad and deep water channel on one level, between Port Said on the Mediterranean, and Suez on the Red Sea. The second, preliminary in point of time, and indeed essential to the construction, as well as to the beneficial use of the canal, was the maintenance of a supply of fresh water sufficient for the wants of the population congregated along the line of canal, and specially at its two extremities. The arrangements for the last-named undertaking had been completed and were described. At Suez, a dry dock, capable of taking in the largest steamer, and an outer port, or basin, were in progress, but these were being carried out by a separate agency.

An account was then given of the character of the works of the salt-water canal, the course of which was traced, and of the state of the works when visited by the author, including the jetty, or breakwater, at Port Said, to protect that port against the action of the north-westerly or prevailing winds.

The opinion arrived at by the author, based upon what he saw and heard during a visit to the canal, and upon a consideration of the correspondence between M. de Lesseps and the late Mr. R. Stephenson, and of the report of Mr. Hawkshaw, dated February, 1863, was:—First, that (subject, of course, to the condition that the relative levels of the Red Sea and the Mediterranean were as stated by the French authorities) there would be no extraordinary difficulty in carrying an open salt-water channel from the Mediterranean to the Red Sea of the depth proposed, namely, 8 metres. Secondly, that no special difficulty in maintaining this channel need be anticipated. Thirdly, that it would be necessary to modify the section proposed by the French engineers, making the side slopes much more gradual. And fourthly, that the cost of maintaining the above-mentioned depth of water would be found at first to be largely in excess of the amount estimated. Eventually, it was by no means impossible that means might be found to fix, or check the drift of sand, or to shut it out from the canal. But for some years it must be expected that the ordinary action of the atmosphere, which had filled up former excavations made in this dry desert, would have the same effect in the new canal. Looking at the work as an engineer, there did not appear to be any difficulty which a skilful application of capital might not overcome.

It was specially resolved that, in order to insure a fuller attendance than would probably be obtained on Easter Tuesday, the meeting should be adjourned until Tuesday evening, 30th April, when it was announced that the discussion upon Sir W. Denison's Paper on "The Suez Canal" would be resumed, and, time permitting, a Paper would be read "On Optical Apparatus used in Lighthouses," by Mr. J. T. Chance, M.A.

INSTITUTION OF NAVAL ARCHITECTS.

The eighth meeting of the Institution of Naval Architects commenced 11th April, at the Society of Arts, Sir J. S. Pakington, M.P., President, in the chair.

The annual report of the council having been read by Mr. Merrifield,

The President said,—Gentlemen, I cannot open this session of this admirable institution for the year 1867, having, as I have, the honour of being your president, without expressing the great and sincere satisfaction which it gives me to meet you again, and also the satisfaction with which I see upon this occasion, as I have upon many former occasions, a very large and numerous attendance of those able and scientific men who take an interest in the prosperity and the progress of this Institution. But, gentlemen, there is one serious drawback to the pleasure which I again feel in filling this chair; and that is, that whilst on former occasions I have always been obliged to offer you some apology, or to request your indulgence, on account of the extent to which, from parliamentary duties, I was obliged to absent myself from the meetings of this society, on the present occasion, from the heavy official duties in which I am engaged (cheers), I am sorry to say I must trust to your kindness and indulgence to allow me, I am afraid, to be absent from the greater part of your proceedings. Indeed, gentlemen, I am so situated this morning that I am now interfering in the prescribed order of our proceedings. You will see in the programme of proceedings the next item of business after the report of the council, which you have just heard, is that the special report of the council on the Safety of Iron Ships ought now to be read to you; but really my time is so limited that I am obliged, I am sorry to say, to request your permission so soon to retire from the room, that I beg to take the liberty of offering to you the few observations which I desire to make before the report of the council is read. Gentlemen, with regard to the contents of the report which you have just had read, I am happy to say that now, as on previous occasions, I can only address you in that language of congratulation which the council have adopted with regard to the continuous, prosperous, and successful action and, I think I may say, the general prosperity of this Institution. There is, I regret to add, a paragraph in this report adverting in somewhat unfavourable terms to the financial position of the Institution; but I am happy to add that this has become the subject of conversation this morning at a preliminary meeting of the council, and I am happy also to say, that although the state of our finances is not so prosperous as the friends of the Institution could desire, still there is nothing at all to forbid the confident hope that financial prosperity may be entirely restored, and that no impediment of that sort may for the future impede or affect the utility and the prosperous action of this society. Those who are members of the Institution have probably received the

Seventh Report, which has been recently published, and therefore it is hardly necessary for me to advert to the valuable nature of that report, and especially to the fact that it contains a very complete index of all our former reports, and I probably should not have thought it worth while to occupy time by any reference to that report, were it not for the acknowledgment which I think is due from every member and every friend of this Institution for the great ability and the laborious zeal with which our secretary, Mr. Merrifield, has prepared that Index which we find so useful. (Cheers.) Gentlemen, there is another topic touched upon in this report which is of immediate importance at all events to the comfort and the means of action of this society. I allude to the fact that we are likely very soon to be obliged to leave the offices in Adelphi Terrace which have been so long occupied by the Institution; and partly with the view to perhaps increased accommodation, and partly with the view, it must be acknowledged, to financial considerations, it has become a question with the council whether or not this valuable Institution, which is acquiring year by year greater national importance, has not a fair claim to receive from the government accommodation in some of the government establishments. (Cheers.) This suggestion has been offered by the council, and I felt it my duty, in consequence of that suggestion, to communicate with the duke of Marlborough, as lord president of the Council, to ask his grace whether in his opinion there were any apartments in any of the government establishments which could, as a temporary arrangement at all events, be occupied by this society. I am very sorry to say I have received from his grace an unfavourable answer. He has taken it into very full and very friendly consideration, and I have received from him a letter to say that neither at South Kensington (and, perhaps, it would be somewhat doubtful whether, even if we could get permission to go to South Kensington, it would be a convenient situation, considering the distance) nor elsewhere can we be accommodated. I am extremely sorry to say that at the present moment I have not received from the lord president any encouraging answer to the application which I conveyed from the council for accommodation in any of the government establishments. It therefore will be necessary, upon the expiration of our term in Adelphi Terrace, which will take place in two or three months from this time, that we should look out for apartments elsewhere. It has been suggested to me that, perhaps, at Somerset House, under some new arrangement hereafter, accommodation might be given to us. At all events, at present Somerset House is fully occupied, and, I believe, there is no chance of our receiving accommodation there within any early period. Therefore I would suggest to the meeting, and I think it is a question for the grave consideration of the council, whether or not it may not be at least worth while—I speak now with perfect freedom from any connection with the Admiralty (Hear, hear)—but I would throw out whether it might not be worth while, considering the important national objects that are carried out by this Institution, to make an application to the Admiralty, and whether or not we might not be considered entitled to an annual grant to assist us in the national objects which we carry out. It must be well known to those whom I am now addressing that in the case of the United Service Institution—no doubt a most valuable institution—both from the War Department and the Admiralty pecuniary assistance is given to carry out the affairs of that institution. Of course this Institution could establish no claim to assistance from the War Department; but I think we might establish a claim, which so far as our finances are not prosperous, might be considered as unanswerable, to have assistance from the Board of Admiralty. At all events, I think it would be worth while for the council, under the circumstances I have adverted to, to make an application of the character to which I have alluded. Gentlemen, I will now advert for a moment to that which has certainly been by far the most important action of this Institution during the year that has elapsed since I had last the honour of meeting you in this chair. It must be, I think, in your recollection that at the time when we met last year, which was somewhat earlier than it is now, the minds of the public were painfully occupied by the dreadful catastrophe which had just occurred in the Bay of Biscay in the loss of the *London* passenger ship. It may be in your recollection that I thought it my duty, in the opening address which I delivered at our last annual meeting, to call the attention of this society to that dreadful event, and to point out to them the opinion that I ventured to entertain, that it would be hardly possible for the able and scientific members of this Institution to address themselves to any question more appropriate to the objects for which we have been called into existence than to inquire whether or not that dreadful catastrophe, accompanied, as it was, by not a few similar accidents about the same time, was or was not to be traced to any defect either in the architectural skill with which our passenger ships are constructed, or to any defect in our laws with regard to the protection of that most important, but quite helpless portion of our fellow-subjects, who are called upon and compelled by their duties and vocations in life to cross the seas, and to become passengers in those ships. The suggestion which I ventured to offer was warmly responded to by the meeting which I had the honour to address, and before the close of our proceedings a motion was made—I think by my friend Mr. Reed, and seconded by Mr. Scott Russell—that the council should devote their serious attention to the question which I had taken the liberty of suggesting. I am happy to inform you, gentlemen, that that part of our proceedings last year has been most satisfactory in its nature, and most honourable to the members of this Institution. The council undertook what certainly has proved a very laborious and a very arduous duty. They commenced their proceedings, if I remember rightly, about the month of May. My many avocations rendered it impossible for me to do that which I would gladly, though perhaps uselessly have done, namely, attend those meetings; therefore I am the more free to speak of the view I entertain of the manner in which those proceedings were conducted. Under the able presidency of our distinguished friend, Sir Edward Belcher, the council met on no less than fourteen different occasions, and in the course of those fourteen sittings they entered in the most close, and able, and satisfactory manner into this most interesting question which has been referred to. Their report was drawn up towards the close of the last year. That report, as I have already stated, if it had not been for the unfortunate pressure on my own time, would already have been read to you. But, gentlemen, it will be read to you as the next proceeding in the business of this morning, and I am confident it must impress the mind of every one who hears it with a deep sense of the great ability and great zeal with which that inquiry has been conducted. I hope and believe that the Institution will attach very great importance to the series of, I think, fifteen suggestions which that report embodies. I think also that I ought to add that it is, I believe, the unanimous feeling of the council that in addition to the suggestions which they have embodied in their report, and which, of course, from the nature of this Institution, relate mainly, if not solely, to the question of the construction of our ships—but I believe I may say it is their unanimous opinion that it would be very desirable that the many remaining questions of a different nature, as affecting our laws for the protection of passengers, should become the subject of inquiry by a Royal Commission. (Hear, hear.) With this view, a deputation from the council did me the honour to request an interview with me upon the subject of their report. That interview took place only a few days ago. At my request, the duke of Richmond, as president of the Board of Trade, did us the favour to join me in receiving that deputation. A more interesting deputation I think I never listened to. It was composed of men most eminent for their acquirements on this subject. The duke of Richmond was deeply struck with the whole of our conversation. What may be the ultimate decision of the government I am at present unable to say; but certainly the question will be taken into consideration by the government whether or not the state of our laws upon this interesting subject are not so far unsatisfactory and incomplete as to make it desirable that the inquiry by a Royal Commission should be added to that inquiry by the council of this Institution which has been already so ably and so completely conducted. (Cheers.) I do not think I need detain you by making any further remarks upon this subject, important as it is. But, gentlemen, there is another subject, by no means a new one, but which is still of the greatest importance; and I will advert to it for a moment, mainly because I am happy to say I can do so with terms of increasing satisfaction. I allude to the continued and successful progress of that School of Naval Architecture, the existence of which is mainly to be attributed to the persevering and zealous exertions of this Institution. (Cheers.) I am happy to say that every report which I hear of the progress of that School of Naval Architecture is satisfactory, with this single exception, that I wish I could hear of a larger proportion of private pupils connected with our own country. At present, a very considerable majority of the pupils in the School of Naval Architecture are those supplied by the Admiralty, and I am informed that many of the number of those that come under the definition of private pupils are foreigners. I think it is a matter of pride and satisfactory reflection that our school should already have attracted so much notice and inspired so much confidence that foreigners find it worth their while to come to England to study in that school; and I have no doubt from the number of government pupils, great impulse has been given to the study of this most important science of naval architecture, and we shall find among the private pupils there will be no inconsiderable supply of competent men added to this profession. But I confess I should be glad to hear, in the first place, that the number of private pupils was increased; and, secondly, that the preparation of those pupils in the study of mathematics was somewhat more satisfactory upon the commencement of their career in the School of Naval Architecture than I am led to suppose at present it is. Gentlemen, I think those subjects of great national interest which have led to the state of transition in which the construction of men-of-war has existed for the last few years. But I think that question of transition is less pressing than it was a short time since. Years have passed away, and a great revolution in the construction of our ships has taken place. Amongst the various questions still remaining, the only one I think I can now speak of as one of very pressing interest, is that question which still certainly remains an unsettled question—I mean the question between the turret system and the broadside system. When I have had the pleasure of addressing you on former occasions, I have thought it my duty, more or less, to touch on this question, and I did so last year; but I think I may now speak of that question as being so far in a satisfactory state that it is in a fair way to practical solution. On former occasions I have felt it my duty to express my regret that the Board of Admiralty—of course speaking here, as I am sure you will fully believe, with no party feeling, and in no party sense (Hear, hear)—but I have felt it my duty in the public interest, to express my regret that, for a considerable period, the late Board of Admiralty, whilst recognizing the importance of the suggestion of the turret, had not taken any adequate steps to carry that question to the state of practical experiment. No further complaints of this kind can exist. The late Board of Admiralty (and I entirely give the credit to the late Board of Admiralty), not so soon as we might have wished, but they eventually did take those steps which I think the public interest and the public voice required, and lately they decided on the commencement of two ships which involved this experiment to its fullest extent, and by which I hope this great experiment and problem will be fairly solved; I allude to the *Monarch*, which I think was designed by my friend Mr. Reed, and with respect to which ship Captain Coles received from the late board, and still more from the present board (for the matter was not quite commenced when the late board went out) *carte blanche* to construct that ship according to what his own views of its construction might be. So that I am happy to say, so far as regards those two ships, that great and important question which has so far divided the nautical world is in course of fair solution, and we must await the trial of those experiments upon a question which I cannot conclude my remarks without adding is a question open to very serious doubt. Gentlemen, I do not remember at this moment any further questions upon which I should desire to touch. I think I may say, echoing, I believe, the opinion of one of our most important members, that if this Institution of Naval Architects were now to vanish from the scene, and this were to be, which I hope is very far from being the case, our last assembly, I think those gentlemen who promoted the establishment of this Institution might well reflect with pride upon the course they took, and with a conviction that this Institution had conferred great public benefits, if it were only in the recollection of the two objects to which I have adverted to-day—first, the establishment of the School of Naval Architecture; and, secondly, that inquiry which has been conducted with so much ability and so much zeal throughout the past year into the construction of those ships which convey our countrymen by sea. Those are the two great subjects, I think I may say those are two great acts; and I cannot close my reference to the last of them, namely, the inquiry into the construction and safety of iron mercantile ships, without expressing—and I hope in doing so I am expressing the sense of every one that hears me—my warm acknowledgment and hearty gratitude to the able

gentlemen who have so well conducted that inquiry. With regard to the future action of the society, so far from any idea of its vanishing from the scene, I confess I, in a sanguine spirit, anticipate for it a career of continual prosperity. Fresh arrangements have lately been made, and they are of the most promising nature. I am very happy to be able to say that, notwithstanding his official avocations and exertions, and the great calls upon his time, which, of course, must be the consequence of his position, Mr. Reed has again joined the active members of this society. (Great cheering.) We are now in the position of having an executive committee consisting of three gentlemen whose competence will be universally acknowledged, namely, Mr. Scott Russell, Mr. Reed, and Mr. Ritchie; and to the very great advantage of this society, and in a manner which demands our warmest acknowledgment, I am happy to say that Mr. Merrifield has given gratuitously his services as the honorary secretary of this Institution. Aided as they are by the zealous assistance of Mr. Campbell, I think I am justified in the hope, with the expression of which hope I will conclude these observations, that through many future years we may look forward to a constant increase of prosperous and successful action, and that year by year this Institution will be more and more recognized as conferring great and important advantages on the country. (Loud cheers.)

Mr. Merrifield, the secretary, then read the special report of the council on the Safety of Ships; after which the president left the chair, which was taken by Thomas Lloyd, Esq, vice-president.

The president of the Institution of Naval Architects, in the opening address of the session of 1866, said, with reference to the then recent loss of the *London*, iron passenger steamer, in the Bay of Biscay, "The circumstances of the sad event of the loss of the *London*, accompanied as it was by the simultaneous loss of another ship of still larger size, and of a higher reputed character" (the *Amalia*), "was, I think, an event so remarkable that I should be sorry indeed if this annual meeting of this Institution were to pass by without some notice being taken of the extraordinary circumstances of the loss of that ship, and without some discussion upon what we suppose to be the causes of the loss, and the faults, if any, of the construction of those ships." . . . . "Regulations must be made, ships must be built for the convenience of passengers, but they must not afterwards be unduly loaded with cargo so as to be unsafe upon the sea. The passengers who pass to and fro are not judges of the question; they can take no precaution for their own safety; it is to the skill and science of those who build these ships that the passenger trusts, and to the care which the legislature and the government are bound to take of their fellow-subjects. Under these circumstances, I do sincerely trust there will be a discussion upon this question."

At the close of the meeting the following resolution was adopted unanimously:

"That in the opinion of the members and associates of this Institution, it is desirable that an early meeting of the council take place, for the purpose of considering, with reference to the president's opening speech, and the papers that have been read on the security of iron ships, what recommendations could best be offered to the public, in order to prevent, as far as possible, the loss of passenger and other vessels."

In accordance with this resolution, the council have given careful consideration to the question of the safety of iron ships, all the members of the council having been consulted at each stage of the proceedings. The council have ultimately arrived at the following conclusions, and offer them, with such recommendations as they contain, to the profession, in the hope that they may be adopted by shipowners and builders, and may tend to increase the safety of passenger and other vessels.

1. No general rule can be safely laid down for regulating the proportions of length and depth to the breadth of a ship, and a great variety of proportions of length and depth to breadth may be safely adopted, and the ship made sound and seaworthy by judicious form, construction, and lading.

2. The construction load water-line of every ship, and her scale of displacement from light to load water-line, should be appended to every design of a ship, showing the extreme draught to which she should be laden; and measures should be taken to insure that this information be recorded on the ship's papers. It is desirable also that, along with the ship's papers, in the possession of the captain, there should always be carried a scale of displacement, a sail draught, and a set of outline plans of the ship, comprising a longitudinal section, and at least four cross sections of the ship. On these plans should be marked the capacity, in tons of 40 cubic feet, of each compartment of the hold. The surplus buoyancy of each compartment up to the load water-line, or its power to carry dead weight, should be given in tons dead weight. These papers should always accompany the ship's register, and a copy of them should be lodged in the custom-house of the port from which the ship hails.

3. There is a minimum height of freeboard which cannot be safely reduced in sea-going ships of ordinary fitment, and it is desirable to fix this minimum height. Freeboard should be understood to be the vertical height of the upper surface of the upper deck (not spar-deck) at the side, amidships, above the load water-line. The proportion of freeboard should increase with the length. One-eighth of the beam is a minimum freeboard for ordinary sea-going ships of not more than five breadths to the length, and $\frac{1}{12}$ of the beam should further be added to the freeboard for each additional breadth in the length of the ship. This would give:

For a ship of 32 feet beam and 160 feet long, 4 feet freeboard.

For a length of 192 feet, 5 feet freeboard.

For a length of 224 feet, 6 feet freeboard.

For a length of 256 feet, 7 feet freeboard, the beam remaining the same; but as the addition of a spar-deck on long vessels may be considered an equivalent or substitute for the increased freeboard required for extra length, a complete spar-deck would leave the freeboard of these extra lengths at the original height of 4 feet.

4. It is not considered desirable to offer any recommendations with regard to poops and forecastles. It must depend entirely upon the professional judgment of the designer of a ship, whether, looking to her proportions, form, and purpose, the additions of poop and forecastle are expedient and safe. In general, where poops and forecastles are adopted, they should be closed and seaworthy, but their weight may be inexpedient in long fine ships; and there are cases where a light top-gallant forecastle (*i.e.*, an open forecastle raised above the level of the upper deck) may be useful in keeping heavy seas out of the ship. In general, spar-decks in long ships are preferable to poop and forecastle, and no diminution of freeboard should be allowed for a poop or forecastle.

5. It would add much to the strength and security of steamships if transverse and longitudinal bulkheads, coal bunkers, iron lower decks, and screw alley were all so connected with the hull of the ship and with each other, as to form independent cellular compartments, water-tight, and having all their communications with the decks and each other by water-tight doors worked from the deck. In proportioning the compartments of a ship (and especially of ships devoted to passengers) it is very desirable so to arrange them as that if any *two* adjacent compartments be filled, or placed in free communication with the sea, the remaining compartments will float the ship. It is considered that no iron passenger ship is well constructed unless her compartments be so proportioned that she would float safely were any *one* of them to fill with water, or be placed in free communication with the sea. Double bottoms are to be regarded as a great element, both of safety and strength, in the structure of a large iron ship.

6. It is very desirable that sufficient ventilation should always be provided in passenger ships to admit of closing all side scuttles and battening down or otherwise inclosing all hatches in bad weather.

7. In regard to hatchways and openings in the deck, no limits can be set to their size; but it is desirable to carry the beams of the ship across them without interruption wherever practicable; the beams may also be made removable where required, being replaced on going to sea. All coamings over engine and boiler rooms in passenger ships should be as high as practicable, of iron, and rivetted to the beams and carlings. Openings in the deck may be fitted with solid coverings, hinged in place so as to be readily closed.

8. It being considered that all openings in the sides or ends of vessels are subject to accidents that endanger the safety of ships, it is desirable that the side and stern windows should, in addition to the gas lights, have *hinged dead lights*, with a view to their being always in place; and that all cargo ports should be strongly secured by iron crossbars.

9. It is believed that all openings from and communications with the sea from engine-room and pipes should be protected by conical, or Kingston, or sluice valves, and similar precautions should be taken for all openings through the bottom of the ship, where damage to pipes or ship would admit water into the holds.

10. It is considered that all steam vessels, if of iron, should have a brass barrelled hand-pump to every compartment except the forward and after ones, the former to have a sluice cock, or that, as a substitute for these pumps, there should be patent pumps having independent connections to this extent. They should also have a donkey-engine and pump capable of pumping from the bilge and from the sea, of feeding the boilers, and of throwing water on deck. All vessels should have one or more bilge pumps, worked by the large engines, with bilge injection pipes if the engines have condensers. In large vessels the donkey engines should have a separate boiler high above the water-line, and also communication with the main boilers. All vessels should have a set of bilge pipes connecting every hold and the engine compartments with these pumps. As a security against fire, there should be pumps on the upper deck, fitted as force pumps, and provided with a sufficient length of hose (with the necessary copper delivery jets) to reach either extremity of the vessel, and also provided with suction hose or pipes from the sea. The cocks, by which the working of the pumps is regulated, should be carefully arranged and marked, and great care should be taken that both cocks and pipes are accessible. A plan of the whole should accompany the ship's papers, and the crew should be periodically exercised in their use.

11. The stowage of a ship, whether done by contract or not, should be done under inspection of the captain of the ship, and should be conducted under his own orders only; and he alone should be held responsible for the good stowage of his ship. Ships are often very badly stowed, the weights being sometimes too low, thus causing them to roll with such rapid and violent motions as to carry away the spars, and otherwise endanger the safety of the ship, and at other times too high, thus making the ships crank, and liable to turn over. A ship may, however, generally, whatever her form, be so stowed as to avoid both dangers. As the character of the ship in these respects varies, so does the number of oscillations she would make per minute, if she were set rolling in still water, by men running across her deck, or other means, and then allowed to come to rest; that is, if the ship be crank, the number of oscillations per minute will be few, and if she be too stiff they will be numerous; but under the same conditions of stowage, the number will always be very nearly the same, whatever the amount of the impulse to set her rolling may be. Although this peculiarity has long been known to scientific men, no such observations have been made in merchant ships as would justify any specific rule on the subject. It is, however, most desirable that information should be collected upon it, and that the attention of the owners and captains of vessels should be called to it.

12. It is believed that the present rules of the Board of Trade regarding boats, life-boats, and their tackle, are good in principle. The responsibility for keeping all boats in constant readiness and efficiency obviously rests on the captain, and must fix on him the blame for all neglect and its consequences. Every open boat built of iron or steel should be fitted with sufficient water-tight spaces to float her.

13. The system of proportioning anchors and cables by Lloyd's, and of proving under license of the Board of Trade by Act of Parliament, is so far satisfactory; but as the proof-test alone cannot establish the excellence of the cable, the reputation of the makers must be relied upon.

14. In order to provide for the rapid clearance of the upper deck from water which may break over the ship, flap-boards should be fitted to the lower part of the bulwarks, sufficient in number and in area to admit of the rapid escape of the water.

15. Water-closets on decks below or near the water-line may be the means of gradually and imperceptibly flooding the ship, and endangering her safety, unless the pipes and valves are strong, and are carefully fitted.

In addition to the foregoing, the council desire to record various recommendations of members, which appear to them to be deserving of consideration, but which have not been embodied therein.

(*To be continued.*)

MONTHLY NOTES.

Sun Spots.—Continued progress in the observation of sun spots, carried on by Mr. Warren De La Rue, in co-operation with the Observatory at Kew, leads to a belief that a connection has been discovered between the behaviour of sun spots and the longitudes of Venus and Jupiter. What this signifies may perhaps be better understood by comparing the phenomenon with that of the moon and tides; for whenever the planets cross the solar equator, that region of the sun becomes more active, and the spots increase in number; and, on the contrary, when the planets are farthest away from the equatorial region, then the spots multiply towards the solar poles. In this we have clearly a case of action and reaction, or, as stated by Mr. De La Rue, "solar activity, as shown in the phenomena sun spots, would not exist but for planetary motion, any more than certain physical phenomena of the planets would be produced without the solar influence." A paper in continuation of a former series is shortly to be published, with particulars of the observations from which these conclusions have been derived.

Fish in the Amazon.—Professor Agassiz, who has lately been engaged in examining the fish of the river Amazon, states that he has not found one fish in common with those in any other fresh-water basin; that different parts of the Amazon have fishes peculiar to themselves; and as an instance of the teeming variety of the Amazon, he adds that a pool of only a few hundred square yards showed 200 different kinds of fish, which is as many as the entire Mississippi can boast. In the Amazon itself 2000 different kinds exist, a great proportion of which are most excellent eating. Several are extremely curious, one especially, which has the power of walking or creeping on dry land, and of worming its way up the trunks of trees.

Excavating Apparatus used in Founding the Piers of the Glasgow Union Railway Bridge.—This bridge, of which we have before published an account at pages 75 and 76, vol. ii., Third Series, has up to the present time made exceedingly slow progress; in fact, we believe the works have been for some time at a stand-still. A peculiar feature, however, attaches to these works in the mode of and apparatus used for excavating the sand in the interior of the tubes forming the pier foundations. This apparatus is shown in the accompanying engraving, in which fig. 1 represents a side elevation, partly in vertical section, of the principal part of the machine, which is termed the excavator; fig. 2 being a plan view. A series of spades or digging and lifting blades, *a*, are hinged to an octagonal iron framework, *b*, into which they exactly fit when closed. The spades are hinged to the outer side or rim of the frame, and are formed with sides projecting inwards,

Fig. 1.

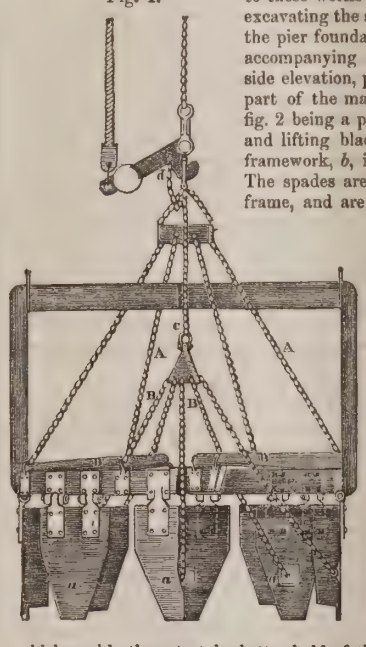
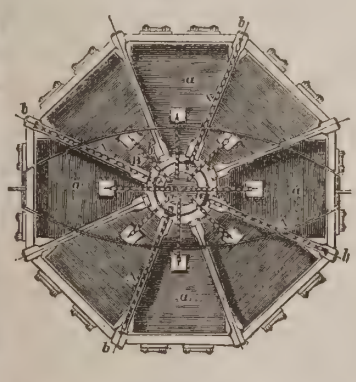


Fig. 2.



which enable them to take better hold of the sand. When the apparatus is being lowered over the spot to be excavated, the spades are open and hang in the position shown in fig. 1. With the spades hanging thus the apparatus is lowered as far as it will go, and the spades having entered the sand are drawn inwards through the ground each into its own opening in the frame, bringing the earth with it. The frame and spades thus brought together form a close vessel, and in this condition the apparatus is drawn to surface full of the sand. To prevent leakage and to make good joints, strips of india-rubber are attached to the underside of the inner octagonal portion of the framework and the T-iron arms connecting the inner and outer framing. Against this india-rubber the edges of the spades press, and when working in soft soils, leakage is thus prevented. The engraving renders the working sufficiently intelligible as not to require further explanation. We may add, however, that Mr. Blair, the engineer to the railway company, reports very favourably as to the economy effected by Mr. Millroy's Excavator.

Croft's Fish-tail Rudders.—The new form of rudder patented by Dr. J. M. Croft has been fitted to so many vessels that its merits must be pretty well known. The inventor reverses the form of the rudder, which was large below and narrow above. He cuts away and rounds off the foot, and gives the broadest section between the heel and the horizontal line. Curved blades of metal are attached, by which it is sought to imitate the bend of the tail of a fish, and thus obtain greater leverage. From the testimonials presented to the patentee, we gather that one spoke of the wheel given to this rudder is equal to two spokes of the old style; and as the vessels answer their helm much quicker, it is especially adapted for the steerage of vessels employed in river navigation. It has been applied not only to sailing and steam ships, but has found favour with the Royal National Lifeboat Institution.

New Apparatus for Hauling Vessels up Slips.—The Bordeaux journals speak of a new invention for hauling ships on to slips, made by Messrs. Moulinle & Labat, shipbuilders of that town. They say that by means of an apparatus of one horse-power a large steamer, called the *Princess Mathilde*, was a few days back easily pulled up an incline of 20 centimetres the metre (rather more than 7½ inches the 3 feet 3¼ inches).

Artificial Wood.—An important branch of industry has recently sprung up in Rhenish Prussia. It consists, writes the *Builder*, in the manufacture of various articles from refuse wood and saw-dust, which are agglomerated by a cement, the exact nature of which is not stated, and then pressed in moulds, so as to form covers for photographic albums, small picture-frames, rosettes, and other ornaments for the use of cabinet makers, &c. For the last-mentioned articles the composition is stained to imitate ebony, mahogany, walnut, and other woods. The composition, or "scrifarine," as it is called, may be sawn, cut, drilled, attached together by glue, and bent on hot plates. It may be polished with oil or French polish, and may be varnished and gilt. A similar composition was manufactured in France a few years ago by mixing fine saw-dust with blood, and submitting it to the action of a hydraulic press.

Italian Petroleum.—A mineral has been discovered in Italy which threatens to prove a formidable rival to the American rock oil. It is called "toccolina," and is produced at a place named Tocco Casawria, near Pescara, in the Southern Neapolitan provinces. It was discovered by an enterprising citizen of Ancona, who has communicated some facts respecting it to our vice-consul, M. Gaggiotti. It appears that this oil for many years was the subject of attention by eminent men, but who, for the want of means or energy, could not carry out any project for utilizing it. The people living near the place paid little or no attention to it, satisfying themselves with gathering some of the liquid, and using it as asphalte for pavements; the rest, which was greatly increased by heavy rains, found its way into the sea. Experiments made upon this bituminous substance by eminent physicists, English, French, and Italian, show that it is likely to offer a serious competition to American petroleum, not only in price, but in quality. It is proposed to form a company, with a moderate capital, in order to work this new branch of industry. Experience has proved, it is said, that 90 per cent. of the raw liquid, after being distilled and refined, can be made use of; whereas American oil can produce little more than 60 per cent. from the raw material. The flame produced from this oil is brighter, we are told, than from any other yet seen. A distillery has been built upon a small scale at Porto Recanati, a few miles from Ancona. The secret of refining, it is said, is known to no one except the projector; and he offers to any company that may be formed in order to carry out upon a larger scale this new industry the benefit of his experience and advice. There can be little doubt now remaining that these bituminous hydrocarbons may be found to exist in every country of our globe.

Why is Time Wasted in Writing thus?—"The waves of sound go only 377 yards in a second, whilst the earth itself goes eighteen and one-third miles, and light ten thousand times faster than that; while electricity (which again is probably another kind of vibration of the solid atoms of bodies, and certainly not a fluid) runs along a wire about half as fast again as light. So, says Mr. Denison, in his 'Astronomy without Mathematics,' if the earth were a cannon ball, shot at the sun from its present distance, with the velocity it now travels with, and the moment of explosion telegraphed to the sun, they would get the telegram there in about five minutes, and see the earth coming in eight minutes, and would have nearly two months to prepare for the blow, which they would receive about fifteen years before they heard the original explosion. This is merely taking the sun as a target to be shot at, without regard to its power of attracting the earth at the final rate of ninety miles a second." Thus may we make comparisons without end; but to the well ordered mind how annoying, stupid, and useless they are! at once of no benefit in any respect, and if read much, producing a most injurious effect on the mental orders. If science is to be taught, let it be done in its real form, pure, simple, and beautiful. It is a reproach to our men of education that some amongst them should trifle thus over the transcendent grandeur of the Kosmos, for no other purpose than to deduce such impotent results. A contemporary every week indulges in a whole column of such stuff, to the disgust, we are well aware, of many of its readers.—V. D.

Yankee Locomotives at the Paris Exhibition.—An American coal-burning locomotive has its boiler and chimney covered with German silver. The driving and trailing wheels are 5 feet 6 inches in diameter, and are coupled together. The front part, with its cow-catcher, is mounted on a four-wheeled truck. The tender is also on two four-wheeled trucks. The cylinders are outside, 16 inches in diameter, with 22-inch stroke. The "cab," or housing for the engine driver, is in polished wood, in true American fashion, and is well finished. The rails upon which the engine stands are laid with Dering's patent rail-fastenings.

Sewage of London.—According to a return furnished by the engineer of the Metropolitan Board of Works, the average daily quantity of sewage pumped into the river Thames at the Southern Outfall Works, Crossness, was 58,362,807 gallons, or 265,169 cubic metres,* equivalent to about as many tons by weight.

The New Addition to the Atlantic Cables.—The manufacture of the new submarine cable which is to be submerged between Placentia (Newfoundland) and Cape Breton is begun at the works of the Telegraph Construction and Maintenance Company, under the direction of Sir Samuel Canning, Mr. Henry Clifford, and Mr. Willoughby Smith. The cable will consist of a core of seven copper wires (No. 18 gauge) weighing 400 lbs. per nautical mile. The wires, precisely similar to those of the Atlantic cables laid last year, will be twisted in a strand, over which will be placed four coatings of gutta percha, alternating with what is known as Chatterton's compound; this again being served with jute yarn. The exterior of the new rope will be, however, somewhat different from that of those previously submerged. The Atlantic

* A cubic metre is equal in volume to 35·3174 cubic feet, or to 220·0967 imperial gallons. It is nearly equivalent to the old English tun of four hogsheads, holding 35·248 cubic feet. It is in general use on the Continent, and is a much better unit for measuring sewage or water supply than the gallon.

cables were covered with ten No. 13 galvanized wires, each wire being coated with five strands of Manilla hemp laid on in a "spiral," and saturated with a preservative compound. The new cable will have twelve No. 9, that is, larger galvanized wires laid on, all in contact with each other, in a quick "spiral." The cable will be about one-third less in size than the Atlantic lines, but will be nevertheless heavier, owing to the additional large exterior wires, and will weigh 42½ cwt. per nautical mile against 36 cwt., the weight of the Atlantic cable for a corresponding distance. The shore end will be also smaller, and this portion will weigh 10 tons per knot. Altogether the new link will measure 321 nautical, or about 360 English miles in length. One of the shore ends will rest at Placentia, which is about 63 statute miles from Heart's Content, to which it is united by a good road, along which telegraph land lines will be placed, and the course of the cable will be first to St. Pierre, a French fishing station, and thence to Sydney, Cape Breton. The extreme depth of water on the route is 252 fathoms, or about a tenth of the greatest depth in which the Atlantic Cables are submerged. The bottom is good, and there is scarcely any doubt that the first attempt to lay the new link to the chain of communication by which Europe is now connected with America will be attended with success. It may be observed that a break is made at St. Pierre, because if the French government should, as is anticipated, lay a line across the Atlantic, this little island would probably be the point to which the western end would be taken, and the cable now in course of construction would, in that case, serve to carry on to the American continent the messages sent by the route established by the French. It is expected that the new cable will be completed about June, when a steamer will take it out to Placentia, and the promoters of the project are confident that it will be in working order on or even before the 1st of August.—*Times.*

American Ladder. The *American Agriculturist* gives a very useful form of ladder which is well adapted for use in gardens or for domestic purposes, as it embraces the convenience of a step ladder as well as of a lean-to ladder. Fig. 1 of our engraving represents the ladder in the form in which it may be used as a step ladder. Fig. 2 shows it extended as a lean-to ladder, and fig. 3 is a detail of one of the joints. One portion or length of the ladder is made rather narrower than the other so as to pass between its sides, and these two portions are jointed together

Fig. 1.

Fig. 2.

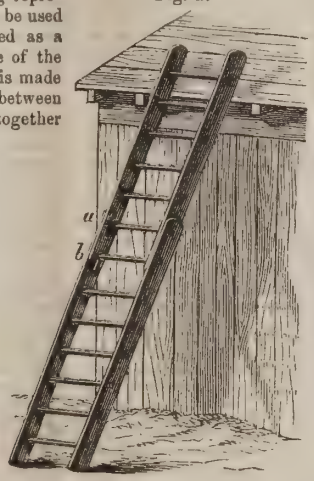


Fig. 3.

by having one of the rounds passed through a slot, *a*, made in the narrow portion, thereby forming a species of hinge; the extreme ends of this portion of the ladder are provided with a deep notch, as at *b*, and shown in enlarged detail at fig. 3. When the ladder is open or fully extended, as in fig. 2, the notched ends, *b*, are slipped on to the second round, and thus lock the parts together; the slot at *a* admitting of sufficient longitudinal play to lock and unlock the joint.

The Sulphur Mines of the Red Sea.—Messrs. Charles Mitchell and Co., of Low Walker, on the Tyne, are building a somewhat curious vessel for exploring the sulphur mines on the islands in the Red Sea. She will be fitted up with large water tanks, and when she has landed men upon those islands she will keep them supplied with water from the mainland. She is a vessel of 300 tons, and will be propelled by a screw.

Jupiter without Moons.—This year a celestial phenomenon will occur which has been only twice recorded in history. On the 21st of August next the planet Jupiter will be seen completely unaccompanied by satellites for nearly two hours. Three of them will be invisible on account of their passing simultaneously over Jupiter's disc, and the fourth will be immersed in the shadow of the planet.

Works of the Holborn Valley Viaduct.—Holborn Hill, from its bottom, at the level of Farringdon Street, up nearly to Fetter Lane, is now inclosed with tall wooden hoardings, which leave but just enough width, on the right hand side of the street, for a single cab or omnibus to pass on its way from the city westwards. The remainder of the roadway, with the site of the many houses lately demolished on the left-hand side, is in the same condition as that of so many other parts of London at the present time—a place given up to contractors, diggers, and builders, to navvies and bricklayers, to carts and wheelbarrows, to piles of materials for masonry, and huge frames of timber, by which the rising masonry is upheld during its construction. The great business here in hand is, of course, that of preparing the foundations of the Holborn Valley Viaduct, which the Corporation of London are constructing on Mr. Haywood's plan. The contractors for this part of the work are Messrs. Hill and Reddell; the engineer is Mr. Neath.

The Mont Cenis Tunnel.—As some misapprehension has of late got afloat with reference to an earlier completion of this work than was formerly anticipated, it is well to publish the following report of Mr. Brunlees, the chief engineer of the railway company.—"5, Victoria Street, Westminister, April 4. To the Directors of the Mont Cenis Railway Company. My Lords and Gentlemen,—I send, for the information of the Board at its meeting to-day specimens of the rocks recently met with in boring the grand tunnel of the Alps. These were obtained by Mr. Blake, our agent for the Summit Railway, on a visit made a few days since to the Tunnel works. You will observe that specimens Nos. 1, 2, and 3, are of gypsum, and the 4th a hard compact limestone. The first was met with at 2462 metres from the Modane end, and the fourth at 2510 metres, consequently 48 metres of the tunnel have been executed in soft material, and to this only can the recent reports of rapid progress refer. The position of the hard compact limestone now just commenced verifies the accuracy of the geological survey on which Mr. Conte made his report, and he anticipates that there is from 2000 to 3000 metres of the material to be got through. My calculation of the time required to finish the tunnel was based on his report, and I see no reason whatever for expecting an earlier completion of that great work than the period stated in my previous estimate. I have the honour to be, my Lords and Gentlemen, your obedient servant,—James Brunlees."

The Thames Embankment.—At the last weekly meeting of the Metropolitan Board of Works, the chief engineer presented his usual report on the progress of the Thames Embankment works, from which it appeared that as regarded that portion of the northern embankment between Westminster and Waterloo bridges, 3216 feet of the low-level sewer, 2477 feet of subway, 2925 feet of small drains, and 320 feet of the Westminster steamboat pier had been constructed. Eastward of the pier, 720 feet of the river wall had been brought above Trinity *datum*, and 115 feet of the parapet had been formed thereon. Progress had also been made with the Charing Cross steamboat pier and the Adelphi landing-stairs. The works in connection with the Waterloo and Whitehall Railway tube were proceeding, and works had been effected to the value of 1200*l*. The total value of works done under this contract amounts to 306,826*l*. As regards the contract between Waterloo Bridge and Temple Gardens, satisfactory progress had been made with the Temple steamboat pier. The river parapet had also progressed, and the total value of the works completed was 203,017*l*. The Abbey Mills pumping station was also going on in a satisfactory manner; the boiler-houses were being put together, and excavations to the extent of 36,500 cubic yards had been made, and 2184 rods of brickwork laid. As to the southern embankment, the works were proceeding most satisfactorily, and the total amount of work completed was of the value of 100,000*l*., of which 5000*l*. represented the progress made in the past month.

Telegraphs to the East.—The secretary to the Treasury has laid before the House of Commons a Treasury minute of the 10th of January, to the effect that while the Board would not consider itself justified in offering a subsidy or guarantee to any company for establishing lines of telegraphic communication, they would be disposed to encourage companies willing to lay down lines of which the government approve, by causing surveys to be made of the proposed route, and rendering assistance by her Majesty's vessels in laying the cables, and also by using the good offices of the government with foreign governments upon whose territories it may be requisite to land cables. The government would stipulate for priority in the despatch of messages, and for the power in certain contingencies of assuming possession of the line upon payment of proper compensation. The lines which the government consider most called for are these:—Falmouth to Gibraltar, Gibraltar to Malta, Egypt to Aden and Kurrachee, Rangoon to Singapore, Singapore or Malacca, *viâ* Java, to Australia, Singapore to Shanghai, *viâ* Hongkong, Shanghai to Yokohama.

APPLICATIONS FOR

PROVISIONAL PROTECTION FOR INVENTIONS

UNDER THE PATENT LAW AMENDMENT ACT.

☞ When the city or town is not mentioned, London is to be understood.

22nd March, 1867.

828 W. R. Lake, Southampton Buildings—Making coffee.—A com.
829 Charles Kaufmann, Paris—Collars and cuffs
830 George Cross and Richard Evans, Winsford—Furnaces for evaporating brine
831 Peter Dickenson, Glasgow—Fences, hurdles, and gates
832 W. W. Gibson, Edinburgh—Decorticating cereals
833 J. H. Winder, Sheffield—Rotary pump
834 George Little, Oldham—Combing cotton and wool
835 E. S. Tucker, Stamford Street—Globular glass
836 Joseph Whitley, Leeds—Stop valves
837 John Lawson, Leeds—Spinning flax, tow, and hemp
838 G. T. Bousfield, Brixton—Manufacturing flour.—A com.
839 George Adams and W. T. Whiteman, Middlesex—Printing railway tickets
840 Samuel Sedgwick, Derby—Rolling spikes
841 John Spencer, Middlesex—Seeding hemp and jute

23rd March, 1867.

842 Henry Wilde, Manchester—Electro-magnetic machines
843 W. H. Rayner and J. T. Heath, London—Knives
844 Robert Duncan, Partick—Cranes
845 J. H. Soller and Edward Barber, Clerkenwell—Umbrellas and parasols
846 J. Gamgee, Bayswater, and A. Gamgee, Edinburgh—Preservation of vegetables
847 Emile Watteeu, Middlesboro'-on-Tees—Nut tapping machine
848 Loxley Horsfield, Leeds—Obtaining motive power
849 Ernest Edwards, Baker Street—Photographic pictures
850 W. J. Hanson, Bradford—Printing yarns
851 C. M. Holland, Tan-y-Bwlch—Permanent way of railways
852 William Busfield, Bradford—Spinning fibrous substances
853 J. G. Tongue, Chancery Lane—Reins.—A com.
854 J. G. Tongue, Chancery Lane—Jumping hoops.—A com.
855 G. T. Bousfield, Brixton—Extinguishing lamps.—A com.
856 Joseph Betteley, Liverpool—Ships' sheathing

25th March, 1867.

857 Thomas Pebardy, Saint Pancras—Stays
858 Henry Fassmann, Chancery Lane—Metal ties
859 George Davies, Serle Street—Rotary digging machines.—A com.
860 William Matthews, Tipton—Draining mines
861 J. H. Johnson, Lincoln's Inn Fields—Treatment of wool.—A com.
862 Robert Higgins, Marchwood Park—Cultivating land
863 Andrew Wyley, Aston Manor—Fire-arms
864 W. E. Newton, Chancery Lane—Cutting stone.—A com.
865 Alexander Parkes, Birmingham—Coating metal tubes
866 William Clark, Chancery Lane—Fire-arms.—A com.

26th March, 1867.

867 Thomas Wrigley, Todmorden—Furnaces or fire-places
868 William Seaton, Sydenham Rise—Permanent way of railways
869 A. S. Stocker, Middlesex—Manufacture of stoppers
870 John Saxby, Kilburn—Railway signals
871 George Davies, Serle Street—Steam gauge.—A com.
872 A. C. Henderson, Charing Cross—Cleansing wool.—A com.
873 James Hesse, Dundalk—Securing buttons and hooks and eyes
874 E. O. Greening, Manchester—Iron and wire continuous fencing
875 A. F. Langin, Paris—Safety carriage
876 W. R. Lake, Chancery Lane—Screws.—A com.
877 Thomas Unsworth, Manchester—Driving bands
878 Joseph Toussaint, Islington—Uniting cork or leather
879 J. S. Morton, Northampton—Communicating from passengers in trains
880 John Wycherley, Prescot—Manufacturing watches
881 H. G. Riggs, Enfield—Locks for fire-arms
882 W. E. Newton, Chancery Lane—Valve gear —A com.
883 E. B. Bigelow, Boston, U. S.—Looms for weaving
884 George Hookham, Summertown—Projectiles for rifles
885 Richard Moreland, Old Street—Construction of floors
886 G. E. Donisthorpe, Leeds—Machinery for getting coal
887 C. E. Sohn, Mark Lane—Posts for telegraphic purposes.—A com.

27th March, 1867.

888 Henry Sharp and F. W. Webb, Bolton-le-Moors—Iron and steel
889 J. M. Jomain, Paris—Venetian blinds
890 C. E. Brooman, Fleet Street—Propelling vessels.—A com.
891 E. W. Shirt, Rotherham—Plane irons
892 G. R. Postlethwaite, Harborne—Manufacture of screw nuts
893 Richard Howson, Middlesborough-on-Tees—Hot-air stoves
894 Henry Fassmann, Chancery Lane—Painting metallic surfaces
895 J. M. Laurent, Lyons—Setting razors
896 Alexander Findlay, Glasgow—Harmoniums, organs, and similar instruments
897 J. Bruckshaw, Oakley Mills, and C. Cornes, Southwark—Reversing motion
898 S. W. Worssam, Chelsea —Cutting wood
899 A. Turner, Leicester, and W. E. Newton, Chancery Lane—Carpets
900 Leon Foinquinos, Liverpool—Envelopes
901 Josef Werndl, Steyr—Fire-arms

28th March, 1867.

902 A. Mackenzie and S. Robinson, Dublin—Preventing waste of water
903 W. R. Dawson and J. B. Davies, London—Protecting ships, forts, &c.
904 W. B. Nation, Old Kent Road—Steam-engines
905 J. Arnold, Bow, and G. Daniel, Stepney—Communication in trains
906 John Grundy, Wolstenholme Hall—Fire-bars
907 William Crighton, Manchester—Preparation of cotton
908 C. D. Abel, Chancery Lane—Optical telegraph.—A com.
909 Thomas Roper, Ulverston—Manufacture of iron and steel
910 F. N. Taylor and J. Lodge, Huddersfield—Doubling yarns
911 D. Foster and R. Cooke, Sheffield—Steel tyres
912 William Clark, Chancery Lane—Saddle stirrups.—A com.
913 William Clark, Chancery Lane—Fire-arms.—A com.
914 William Wood, Monkhill—Engines for washing rags
915 M. P. W. Boulton, Tew Park—Receiving motion from fluids
916 Nathan Thompson, Abbey Gardens—Bottles
917 G. A. Buchholz, Shepherd's Bush—Manufacturing semolina
918 J. Howard and E. T. Bousfield, Bedford—Cutting grasses
919 W. R. Lake, Chancery Lane—Extracts of bark.—A com.
920 W. R. Lake, Chancery Lane—Extracts of bark.—A com.

29th March, 1867.

921 J. H. Johnson, Lincoln's Inn Field—Decanting wines.—A com.
922 E. H. Aydon, Wandsworth, and E. Field, Westminster—Smelting iron
923 J. G. Tongue, Chancery Lane—Lace, warp, and knitting machinery.—A com.
924 Philander Shaw, Boston, U. S.—Air engine
925 Kenyon Barnes, Clowes—Condensing steam engines
926 J. A. Simpson, Liverpool—Umbrellas and parasols
927 Walter Easterbrook, Kilburn—Actuating railway points
928 Eugène Canton, La Rochelle—Controlling cock for liquids
929 Michael Henry, Fleet Street—Musical instruments.—A com.
930 A. Barff and J. Kidd, London—Utilizing petroleum
931 W. B. Hilliard, Glasgow—Skates
932 George Davies, Serle Street—Decorating metals.—A com.
933 William Clark, Chancery Lane—Manure.—A com.
934 William Wood, Monkhill—Preparation of rags
935 James Bird and James Bird, London—Artificial fuel
936 E. W. Ball, Birmingham—Gas fireplaces
937 Joseph Wolverson, Birmingham—Locks and keys
938 William Bywater, Holbeck—Spinning flax
939 W. Gadd and L. Baillon, Nottingham—Boot elastic web
940 B. Farmer and T. Balmforth, Barrow-in-Furness—Steel bells

30th March, 1867.

941 R. Canham and F. W. Kreut, London—Cure of smoky chimneys
942 J. E. Ward, Bredbury—Manufacture of hats
943 E. S. Jones, Liverpool—Rowing boats on water
944 Thomas Prideaux, Sheffield—Blast furnaces
945 James Macnee, Edinburgh—Movable hoods for carriages
946 S. M. Grover, Worsley—Doubling or twisting cotton
947 W. B. Woodbury, Rusholme, and R. H. Ashton, Ashton-upon-Mersey—Designs upon paper
948 R. H. Collyer, Dundee—Treatment of flax
949 John Fleming, Glasgow—Bending and circling metallic plates
950 Simeon Lilley, Birmingham—Fog or alarm signals
951 J. J. M'Comb, Liverpool—Coupling telegraph wires.—A com.
952 W. E. Newton, Chancery Lane—Manufacturing ice.—A com.
953 W. E. Newton, Chancery Lane—Hydraulic engine.—A com.
954 William Clark, Chancery Lane—Bricks and tiles.—A com.
955 George Higginson, Preston—Producing opaline pictures
956 H. A. Bonneville, Bayswater—Hanging ships' rudder.—A com.
957 H. A. Bonneville, Bayswater—Fid.—A com.
958 H. A. Bonneville, Bayswater—Making brooms.—A com.
959 J. Randall and C. Adams, Kilburn—Actuating fog signals
960 Friedrich Hahn, Tavistock Street—Manufacture of gunpowder
961 Friedrich Hahn, Tavistock Street—Needle guns
962 F. J. Manceaux, Paris—Fire-arms
963 Joseph Whitworth, Manchester—Fire-arms
964 J. G. Jones, Newport—Getting coal

1st April, 1867.

965 C. D. Abel, Chancery Lane—Treating fluids.—A com.
966 W. R. Lake, Chancery Lane—Closing ports of ships.—A com.
967 John Harker, Great Driffield—Expressing oils
968 C. E. Brooman, Fleet Street—Producing surfaces in relief.—A com.
969 John Prentice, New York, U.S.—Making cigars
970 A. V. Newton, Chancery Lane—Sewing machinery.—A com.
971 Francis Curtis, Newton—Paper machinery
972 Joseph Lewis and George Clark, London—Fire-arms

2nd April, 1867.

973 H. A. Bonneville, Bayswater—Economizing motive power.—A com.
974 H. A. Bonneville, Bayswater—Lighting fires.—A com.
975 H. A. Bonneville, Bayswater—Railway brake.—A com.
976 Robert Wolstenholme, Oldham—Textile fabrics
977 J. J. Meyer and A. Meyer, Mulhouse—Locomotive engine
978 W. R. Lake, Chancery Lane—Manufacturing boxes.—A com.
979 Joseph Storey and W. E. Bickerdike, Lancaster, and W. V. Wilson, Mile-End—Bronzing metallic surfaces
980 W. E. Newton, Chancery Lane—Sugar machines.—A com.
981 T. B. Robinson, Islington—Artificial flowers
982 James Shanks, Arbroath—Clipping horses
983 Jost Mahler, Lucerne—Coverings for internal walls
984 J. A. Moll, Bern—Obtaining motive power
985 William Clark, Chancery Lane—Bathing apparatus —A com.
986 William Clark, Chancery Lane—Copying letters.—A com.
987 William Clark, Chancery Lane—Weaving fabrics.—A com.
988 William Clark, Chancery Lane—Fitting tubes of boilers.—A com.
989 J. F. Reeves, Cambridge Terrace—Explosive compounds

3rd April, 1867.

990 Jonathan Pickering, Stockton-on-Tees—Raising weights
991 James Whitehurst, Manchester, and Thomas Walsh, Salford—Looms
992 E. H. Waldenström, Manchester—Miners' safety lamps
993 James Musgrave, Belfast—Fittings for stables
994 A. S. Hallidie, Strand—Suspension bridges
995 William Clark, Chancery Lane—Ear stoppers.—A com.
996 Théodore Faucheux, Kentish Town—Boats
997 Peter Spence, Newton Heath—Separating zinc
998 J. A. Bouck, Manchester—Burning petroleum
999 J. W. Scott, Worcester—Needles
1000 G. E. V. Derburgh, New York, U.S.—Stone for grinding
1001 A. G. Hills, Strand—Safety-bridle
1002 Eugène Delessert, London—Cartridges.—A com.
1003 W. Stafford and W. P. M'Callum, Blackburn—Heating feed water of steam boilers
1004 J. H. Barker, Leeds—Milling machines
1005 John Ogden, Leeds, and John Stephenson, Bradford—Steam boilers
1006 William Hodson, Kingston-upon-Hull—Bricks
1007 W. R. Lake, Chancery Lane—Fire-arms.—A com.

4th April, 1867.

1008 Henry Davey, Strand—Obtaining motive power
1009 Joseph Ladley, Leeds—Spinning wool
1010 W. C. Webber, Mentone—Feeding bottles
1011 Edwin Pilling and John Harper, Rochdale—Looms
1012 Stanhope Perkins, Fairfield—Railway crossings
1013 John Petrie, Rochdale—Washing wool
1014 Edward Casper, London—Extinguishing fires.—A com.
1015 J. M. Kilner, Chester—Laying submarine telegraph cables
1016 B. Fowler, Cornhill, and D. Greig, Leeds—Railways and engines

5th April, 1867.

1017 Daniel Ellison, Manchester—Looms
1018 Henry Buss, Shoreditch—Sea-walls, quays, jetties, and piers
1019 W. Tatham and W. T. Heap, Rochdale—Teazing fibrous materials
1020 Samuel Leather, Dalton—Wearing apparel
1021 J. G. Tatters, Plymouth—Communicating in railway trains
1022 T. B. Marshall, Cheapside—Telegraphs
1023 W. A. Gilbee, Finsbury—Fire-arms.—A com.
1024 F. A. Mocquard, Marseille—Gas burners
1025 Edward Beningfield, Old Kent Road—Lifting machine
1026 Stephen Matthews, Portsea—Lift and force pump
1027 William Adair, Liverpool—Pumps
1028 W. E. Newton, Chancery Lane—Steam generators.—A com.
1029 Henry Wilson, Stockton-on-Tees—Cocks or valves

6th April, 1867.

1030 F. A. Fitton and Thomas Hall, Manchester—Spindles and flyers
1031 Robert Neild, Thomas Smith, and John Yates, Leigh—Looms
1032 Joseph Woods, Warrington—Signalling on railways
1033 William Dennis, Aldermanbury—Bottles
1034 W. P. Butchart, Dundee—Treating, jute, hemp, and flax
1035 Jules de la Coux des Rosesux, Paris—Lubricator for oiling axles
1036 T. H. Lucas, Manchester—Fastening bales of merchandise
1037 Graham Stuart, Sheffield—Taps and valves
1038 William Clark, Chancery Lane—Lamps.—A com.
1039 W. W. Hughes, Hyde Park—Propelling vessels
1040 C. E. Brooman, Fleet Street—Producing oxygen.—A com.
1041 John Drew, Edward Southwell, and Henry White, London—Travelling bags
1042 William Henderson, Glasgow—Oxidizing minerals
1043 James Barker, Ratcliff Cross—Spring centres for doors
1044 W. R. Lake, Chancery Lane—Embalming bodies.—A com.
1045 W. R. Lake, Chancery Lane—Water-meter.—A com.

8th April, 1867.

1046 H. A. Bonneville, Bayswater—Soap.—A com.
1047 G. F. James, Salford—Covering woollen yarns
1048 W. T. Henley, London—Posts for telegraph wires
1049 W. T. Henley, London—Wire
1050 W. E. Newton, Chancery Lane—Shells and projectiles—A com.
1051 William Clark, Chancery Lane—Cutting scale-board.—A com.
1052 C. E. Brooman, Fleet Street—Jacquard machinery.—A com.
1053 George Little, New York, U. S.—Regulating electric currents
1054 C. E. Claus, Middlesborough-on-Tees—Chlorine

9th April, 1867.

1055 D. J. Fleetwood, Birmingham—Spoons and forks
1056 R. A. Rooney, Browneville—Railways and trucks
1057 W. N. Wilson, London—Sewing machines
1058 J. L. Davies, Manchester—Purifying smoke.—A com.
1059 Hugh Forbes, Euston Road—Maintaining motive power
1060 Augustin Morel, Roubaix—Winding thread
1061 Thomas Redmayne and John Sibrey, Kilnhurst—Register fire grates
1062 Francis Waller, Skipton—Spring for doors

10th April, 1867.

1063 John Ratcliffe and George Wolstencroft, Farnworth—Looms
1064 J. H. Player, Birmingham—Phosphorus
1065 Francis Lowe, Thomas Davy, and John Metcalf, Stanningley—Pressing iron
1066 J. R. Napier and W. J. M. Rankine, Glasgow—Valve seats
1067 J. H. Johnson, Lincoln's Inn Fields—Hammers.—A com.
1068 A. V. Newton, Chancery Lane—Picking and ginning cotton.—A com.
1069 W. R. Lake, Chancery Lane—Fire-arms.—A com.
1070 W. C. Cambridge, Bristol—Fire bars

THE PARIS EXHIBITION.—MOTORS.

By the Editor.

On the present occasion we propose to notice, in a somewhat loose or non-methodized way, a few of the more important classes of objects or single objects exhibited, which either by novelty or excellence, or in some other respect, should more especially challenge the attention of our readers, and in particular such of them as purpose personally visiting the Exhibition. We earnestly recommend all our countrymen who are more or less directly connected with Industrial art, to visit the vast display and judge for themselves. Why the British newspapers should have so generally, if not universally, written of the Exhibition in a slighting or even condemnatory tone is to us inexplicable; for we cannot credit the rumours we have heard of paltry feelings arising out of some supposed want of deference to the representatives of the English press at Paris, who in order to gain access to the building have, like other people, to pay for their tickets. This however we say, in the most unhesitating way, the existing Exhibition is not only by far the vastest collection which has been ever brought together, but it is upon the whole the best arranged collection, and the most readily and thoroughly capable of being examined that has been produced. As to the objects themselves, widely diffused novelty is not to be expected—it is not possible; but there is much that is new, much that is important, and to none more so than to Englishmen; much to surprise and delight those who can look with previously instructed eyes, plenty and more than enough to be enjoyed by even the least skilled or the most idle.

The steam-engines exhibited may be reckoned by hundreds; many at work, many more at rest. As we pass rapidly along the great machinery zone, on both sides of the elevated gallery, we find in great numbers land (or fixed) engines employed in driving portions of the not far from mile and a half of shafting which, bracketted upon the gallery pillars, actuates the innumerable machines in motion. Many of these are very large engines, 75 or 100 horse-power (nominal power) not being uncommon, though none probably are working up to nearly their full power. Their characteristics are very various, and in certain respects as regards the foreign made engines very striking, or ought to be, to the English eye, affording a lesson as to the persevering pains that have been and are still being taken by the continental engine makers to economize coal. Were we asked by what more than anything these foreign engines are distinguished in design, we should say, by the almost universal adoption of the Woolf's plan of construction with two cylinders. Coupled engines are obviously very widely preferred for manufacturing uses; and French, Belgian, and German makers appear in nothing deterred by the apparent complication of four cylinders, along with the usual following of condensors and air pumps, &c., while they can in the end secure perfect uniformity of movement with the utmost economy of fuel. Some of these continental Woolf's engines have vertical cylinders and working beams overhead, with ponderous cast-iron columns and entablature framing; but very many are horizontal engines in which mere appearance has been plainly held secondary to excellence and simplicity. Of these horizontal double-cylindered engines there are three distinct types, as to arrangement of cylinders and pistons; viz., 1. the two cylinders side by side, and the two pistons working (as in the vertical-cylindered engines) simultaneously, so as both to reach the same end of both cylinders together; 2. the two cylinders side by side, but the two pistons independent, *i.e.*, each with its own connecting rod, and passing to the opposite necks of the two-throw crank which constitutes the fly-shaft, so that when one piston, say that of the small or high-pressure cylinder, is at the one end of its cylinder, the other or low-pressure piston is at the opposite end of its cylinder, and *vice versâ*; 3. the high and low pressure cylinders are end to end, having a common horizontal axis, the smaller cylinder being next the crank shaft. This is, in fact, the arrangement of Mr. Sims, of Redruth, Cornwall, and Mr. Edward Humphry's arrangement of marine engine, but laid horizontally. There are some positive advantages in the second arrangement, as respects the admission and emission valves.

Almost all the engines exhibited work expansively, and innumerable are the modifications of valve gear shown for effecting this. In most of the Woolf's engines the cut-off of the high-pressure steam in the small cylinder is effected by a special slide, with the means of varying the amount of expansion, and with this always under the control of the governor. Cap slides of the well-known style, though varied and often improved in detail, are very frequent; but double-seated valves, lifted by tappets or by cams, and several other forms of lifting valves, are also to be seen. Many of these valve arrangements show a very high degree of ingenuity, and a thorough appreciation of correct principles.

There are some double-cylindered engines shown amongst the British fixed engines, and by no means devoid of merit, but the palm for this construction unquestionably remains with the French and Belgians. It is very remarkable also how greatly both these nations have improved since 1862 in the proportioning of their parts, especially of their framing. Amongst the single-cylindered horizontal engines working expansively are some also of great excellence; for example, that of Le Gavrian et Fils, of Lille, of 100 horse-power, a plain but handsome, strong, well made job, just the right sort of thing for a factory engine. There are also excellent engines of this type by Prospere Vandenkerchove, of Gand. France also shows several of what might be called "full dress engines," finished in a very ornate and elaborate style, for delicate civic manufacturing uses, such as silk working, chocolate grinding, &c., and at the same time of rare excellence in design. One of these, a vertical framed engine, consisting of two double cylinders set at right angles to each other, and each at 45° to the horizontal line, and working upon a crank common to both, presents an exquisite example of beauty of form and proportion, in its strong but graceful cast-iron framing, and of original conception in the arrangement of its details.

England, Germany, and America (we believe) all show engines on the Corliss construction. The first has a modification in construction of the valve stem clutches or nippers; now made to catch both above and below the stem, which may be almost called new. The constant, sharp, hammer-like click of this valve gear when at work tells to the ear, however, that its wear and tear must be far from insensible; and that this wear must involve much periodic care, if not reparation, of the hooked catches thus sharply struck, any failure in the detent of which is for the moment fatal, and yet the prevention of which rests simply upon the sharp and unworn state of these catches. Great as are the advantages, which do not admit of doubt, of the Corliss engine, it has, besides the above, another disadvantage, it is not possible to work it fast; the nature of the valve gear will not admit of that. The very reverse of this we have shown in the English display—in the Allen engine of Mr. Porter, as now made under his direction, and from his designs, by the Whitworth Company of Manchester. This engine we, in 1862, pronounced, when it was a mere exotic little interloper upon a very humble scale, and passed by at first by many, in the Record of that Exhibition, to be the very best engine, as regarded merit of design and clear appreciation of the conditions of theoretic perfection, intelligently carried out, in the display of that time. We have it here again, but now upon a far larger scale, improved in its proportions as well as in style of workmanship (as to which, indeed, it is only necessary to have stated that it is made by the Whitworth Company), and no longer a mere high-pressure, but now a high pressure, expansive, and condensing engine. The construction is, as in 1862, horizontal; the valve gear the same in principle, which won its earliest success, but improved in some details, as is also the framing; and with an air-pump, which has considerable pretensions to be declared a novelty. It works away as steadily and silently as an astronomical clock, though running at the railway pace of 800 feet piston speed per minute. We have not as yet had any opportunity of seeing indicator diagrams from this engine, which is driving a quantity of machinery, so that we can say nothing definitely as to the *degree* of its merits; but we will hazard this opinion, that while certainly nothing is likely to prove better than this in the British section, we shall be surprised if anything prove better than its performance in the entire Exhibition.

There will be some difficulty in determining in a rigid manner the merit of any of the engines, if such be attempted, which we much doubt; for as all are supplied with steam from boilers outside the building, and at various and great distances from the engines, and as there is no means of determining the weight of steam, at given pressure, delivered per unit of time to each engine, so will it be impossible, unless such means shall be provided, to obtain any precise relation between the steam consumed and the work done. And if this be so, how great a cause is it for regret. What in reality is the use of these Great Exhibitions beyond mere shows, if the conditions be such—whether through the exigencies of the place or those of time, and the want of salaried officers of competence and in sufficient numbers to conduct and record such experiments—that no really scientific comparisons of excellence in motors, or other important machinery, can be made?

The great aim of the foreign engine maker at present he sums up in the phrase, 1 kilogramme per hour (2·2 lbs. nearly) per actual horse-power. A few profess to surpass this; many unquestionably do not touch it. Who is to know who has nearest reached the highest goal of economy, if the means of trial be inadequate, and if those charged with the trial are incompetent to the delicate and careful experimentalization needed to get true results under, as here, very various and often complex conditions? In the British section we have understood that an officer of Royal Engineers has been appointed to undertake this duty. Many of the officers of that corps have no doubt a sufficient basis of sound scientific knowledge that they *might*, after a sufficient time for probation and study, acquire the knowledge requisite; but we take leave respectfully to doubt that there is a single man in the corps at this moment competent to the task. Great Britain could not better nor more wisely expend a few hundred pounds than by retaining a special commission of say three of her most competent mechanical engineers (we shall suggest no names amongst a list so large as comes to mind), and requesting them to devote ample time to examination and experiment upon all the more important motors in the Exhibition, ending in a full, descriptive, and critical report and comparison.

The more the observer knows about the subject, the more he will see that, as was seen in 1862, so is seen now, but in still larger proportion, that the relative improvement of the continental makers, not only of motors, but of every class of machinery, and of most primary products, has been during the last interval far greater than our own. Our day for bumptious, self-laudatory boasting, at least is passing away, if not already gone. Conversing, as we have done, with many of the best and most instructed men that England has sent forth to this Exhibition at Paris, we find but one feeling of sober wisdom resting in every mind, that it does an Englishman good to have some of his apathetic pride and prejudice shaken out of him by what he sees and encounters now there, not only at the Exhibition, but in and around Paris itself.

But a few days ago, through the good offices of some of the authorities, a party was arranged of several British engineers and mechanicians to visit the world beneath Paris—to see its best and newest main drainage. We shall not here digress to describe; but, talk of *Cloaca Maxima!* leave such stuff to the antiquarians who began the talk; rather let those whose knowledge fits them consider whether, with all our main drainage, we have not yet much to learn here, and in other directions, from the civil engineers of France.

Locomotive engines are largely shown, though we can at the most, perhaps, reckon them by dozens, in place of hundreds. England shows good, substantial, and exact workmanship, with the general simplicity of design that goes before effectiveness. There are also ponderous and powerful engines by French and Belgian makers, and by many from Switzerland, the small German states, Prussia, and Austria. In these latter countries, as well as in Italy, where the Genoa and Pistoija Railway lately opened, with some of the sharpest gradients in Europe, the gradients of very many lines necessitate a tractive power not demanded upon our English flat lines. Engines on eight, ten, and even twelve wheels, all coupled together, are not uncommon. One or two of these colossal engines were shown in 1862; but the type has since been in many respects greatly improved, and the details simplified. Amongst this class of locomotive there is probably none so remarkable as that exhibited by the Maschinenfabrik von Ostereichesches Staats Eisen-Gesellschafft, of which Mr. Haswell, the inventor of the steam-pressure forging machine, is director. This huge engine has six wheels on three axles, and four more united into a "bogie;" the whole of the ten wheels are coupled, and receive power directly from the cylinders, which are outside the framing. Nothing can be more ingenious than the way in which the power from the cylinders is transmitted *constantly* on to the four "bogie" wheels, and yet the "bogie" itself left perfectly free with its wheels to swivel horizontally in going round curves. There are steam brakes fitted to this immense engine, pressing upon the top of the wheel tyres; and it is prepared to work at 100 lbs. pressure. This is far from the limit of pressure in these foreign engines, however; 150 lbs. per inch (which is probably the circular inch) is seen elsewhere. The specially learned English visitor will see much to interest and something to instruct him in many of these foreign locomotives; but probably few points about them will more arrest his attention, or do so in a less agreeable manner, than when the engine marked Delhi, East India Railway, in the exhibits of the smaller German states, meets his eye. There he will see a right good engine, not, so far as appears, constructed from English designs either, but from those of Herr Emil Kessler, the directing engineer of the Maschine Fabrik von Eslingen, at Wirtemberg, one of a pretty large order constructed there for our own Great East India Railway Company. Is this handwriting on the wall?

America (United States) does not make a very striking display, except in her vast agricultural annex to the west side of the park, in any way; but she does produce a locomotive, tawdry and would-be grandiose, but best at a distance. Some of her land engines too, notably an Allen engine, covered over with polished steel plates and mouldings, and looking rather like a bright ironmongery stove or gigantic piece of cutlery than a sober-minded machine fit for real work, are examples of that utter want of genuine good taste which characterizes that country generally, and is, perhaps, an inevitable phase through which its national mind must pass, as its men change, with the march of time and events, from the feelings and habits of backwoodsmen and rail splitters to those which belong to the old civilizations and traditions of Europe.

Of foreign engines for mining purposes there are many highly noteworthy examples, especially in Belgium and France. The Societé Anonyme de Chatelineau, of which M. Eugene Smits is administrator and gerant, that is to say, director and trustee, shows a very meritorious though not very well-looking pair of winding engines for colliery use, consisting of a pair of high-pressure inverted cylinders set on top of hollow frames, each of which is in shape a frustum of a cone, like a small windmill tower, within which the pendulous connecting rods work, and beneath the bases and across the central axes of both of which the main crank shaft, carrying the flat rope drums, works. The engines are handled by a pair of levers at one spot, very well placed for the engine tenter, and close to whose hand is placed a third lever which actuates the powerful steam brake, by which the drums and rope are arrested. The valve gear is a link motion—a movement, we may mention, which presents itself in very numerous instances, in all classes of engines and in all countries, in the Exhibition.

Near the above engines are another pair with ponderous ribbed cast-iron framing, also with inverted cylinders—a very good job too, better looking than the Chatelineau one, but less scientific in design; indeed the Chatelineau engines only wanted the eye of taste in the designer of the framing to have had a much more favourable reception generally than they are likely to get.

Though there is so much to praise and to admire in the foreign engine-makers' work, we come now and then to works of which little that is good can be said, and sometimes too where they bear the names of well known and much honoured firms as their constructors.

Thus, a blast engine is shown in Belgium from the successors of the world famous John Cockerell, the Societé de Cockerell, of Liege, which consists of a large Woolf's engine with vertical double cylinders, fixed upon a baseplate between four lofty and gaunt cast-iron columns, upon the top of which stands a cast-iron plate, like the top of a very little table on four very tall legs, and upon this is placed a ponderous blast cylinder. We are informed by an inscription in front of this engine that forty-two blast engines of the same styles have been turned out by this company: a surprising announcement, for it is scarcely possible to find anything about this engine that deserves aught but condemnation. The style of the framing is that abominable sort of thing that used to be turned out twenty-five years ago by Liverpool and Glasgow in marine-engine framing, and called Gothic: Heaven forgive the men that had such an idea of Gothic architecture! The framing depends for some of its lateral stiffness upon the two steam cylinders, parts that never should be called upon in any engine to resist cross strains; and between the bad arrangements for working the air pump and water pump from off *one side* of the crosshead over the two cylinder tops, and the ponderous top load, we make no doubt the blast cylinder and its table top base will rock to and fro when at work in a very threatening manner. The blast cylinder, too, has not a redeeming feature that we could see about it; common class valves, and even these admitting of obvious improvements in position and in proportion. The uniformity of rotation is kept up by two fly-wheels upon either end of a main shaft, which with its bearings are under the bedplate, and these are worked by two large side connecting rods which come down from the crosshead above the cylinders with this sole function in view.

Marine engines are not shown very numerously; and England is far from being represented, even in model, according to her undoubted merits. Most of the marine-engine work is in a shed or annex outside

the park, and upon the water edge of the Seine, close to the west side of the Pont de Jena. In this building are a few well executed English models, and the engines complete, by two different makers for men of war launches, both good; but no engines, except a pair by a single maker, upon a full size scale, represent England. America shows no marine engines of her peculiar types. The Creusot Company of France, however, have spent a prodigious sum in erecting in place, and in a manner admitting of their being set to work, a complete pair of marine horizontal engines of the very largest class for ocean navigation or war purposes, with the whole of their boilers, and with the entire length of screw shaft, and with the propellor itself. These, ere this will appear in type, will probably have been put into motion, and will undoubtedly be one of the most striking objects to the "sight seer" in the Exhibition. It would require a larger space than we have now at command to describe and criticise these engines, which are, we may say in passing, very noble pieces of workmanship.

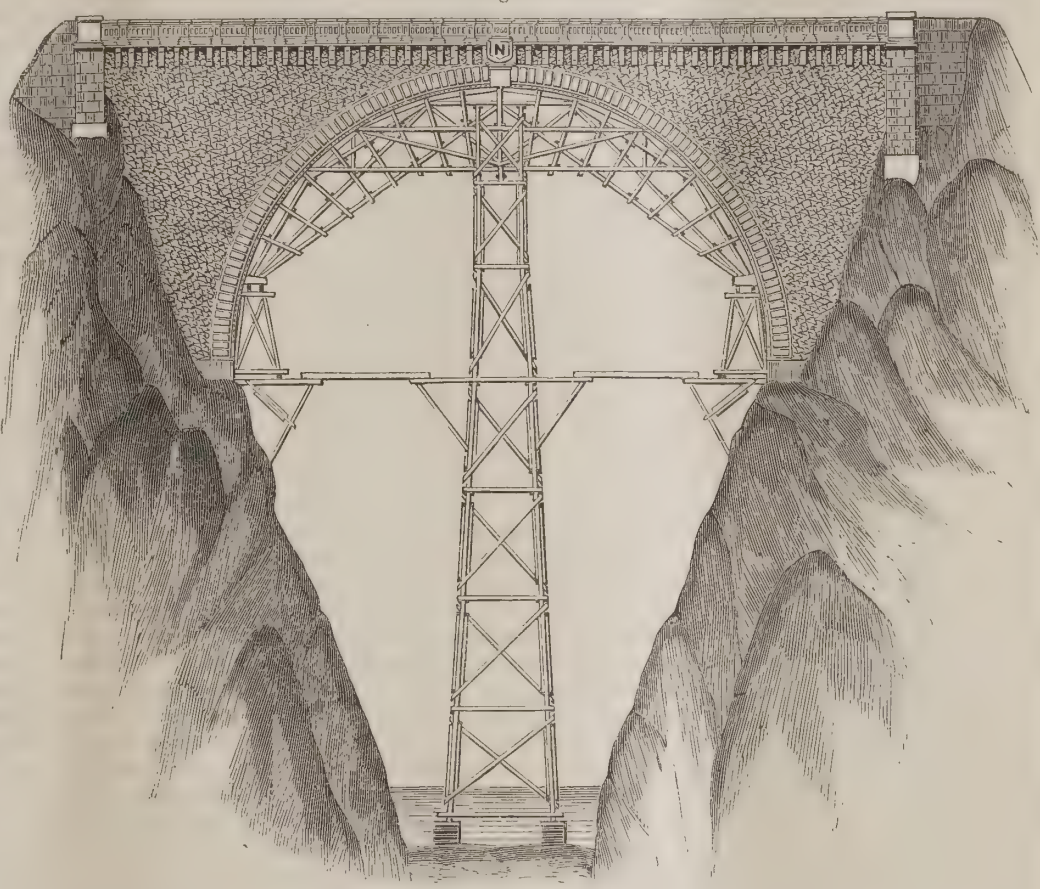
As to locomobiles, their name is legion, and great excellence in workmanship is evinced in many of those of foreign make. Like many another thing that now strikes the attention here, the locomobile was distinctively an English invention and original product, just as was the Woolf's engine; but nothing more impresses the reflective observer than the rapidity with which our foreign friends copy all that is good, and soon more or less improve upon what may remain, indifferent or bad, in productions of our inventive skill. As regards other motors than those of steam, there are gas engines, and one other than the Lenoir, and alleged to be in one point superior to the latter, in that it requires no electric spark to kindle the gases. There are also electro-dynamic engines, machines receptive of water power, in all their known forms and varieties, but to treat of which would need a distinct article; and also hot-air engines. The most remarkable of these is the hot-air engine of Mr. Philander Shaw, of Boston, Massachusetts, exhibited though in Class 53 (No. 164 Catal.), in a small separate building in the park, not far from the British Boiler House. This engine, which passes the air taken in, with all the products of combustion of the fire, right through the engine, is remarkable in the fact that the means provided for keeping the pistons perfectly cool, and hence lubricated, are effective, and that methods of great ingenuity and simplicity have been devised and adopted for preventing the ashes or grit swept away with the air from the burnt fuel from reaching the working parts of the interior of the machine.

EXAMPLES OF BRIDGE ENGINEERING AT THE PARIS EXHIBITION.

The Pont Napoleon.

In Great Britain, engineers have constructed numerous majestic works of the bridge class, including viaducts, aqueducts, and bridges proper, many of them both bold and magnificent in design, others conspicuous and notorious as structural deformities. Amongst them we may mention, beginning in the order of creation with Telford's original airy suspension bridges across the Menai Straits and at Conway, which were afterwards pulled down in making way for the massive Britannia tubes of Fairbairn and the second Stephenson. There is the Newcastle High Level, as well as the Crumlin viaduct, and Brunel's great structure (the Albert Bridge) across the Tamar, linking together the two counties of Devon and Cornwall; added to which are the whole pack of viaducts (many of still greater height than the Saltash tubes) spanning high over the valleys that intersect the counties of tin and copper; neither must we omit Sir John Macneil's great work across the Boyne at Drogheda. There are also, proceeding in another direction, the several splendid metropolitan works spanning the Thames from London Bridge (the elder Rennie's world-renowned conception), Waterloo, New Westminster, &c., and others ripening for execution elsewhere in the United Kingdom. Nor may we omit to mention the dozens of bridge-like structures in the Midland counties for carrying railways, canals, roads, &c. Then again there is

Fig. 1.



the famous Grosvenor bridge of stone in a single span, which so majestically sits across the Dee, as well as the viaduct across the same river in the Vale of Llangollen; Mr. Fowler's great cast-iron arch across the Severn; and a host of others that we need not mention. Differing from all or any of these examples at home, we find the nature of Alpine and Pyrenean countries impose an altogether different class of conditions to be encountered by bridge builders, such as yawning chasms hundreds of fathoms deep, with wildly gushing torrents in the bottom of the gorge, frequently unapproachable by the hand of man, and known only to exist by the rumbling tumult echoing out of the rocky hollow, the sides always precipitous, frequently not many degrees off the vertical; or again we find a low lying and wide-spread valley gaping between mountains, from one side of which a railway or road has to be carried on the same level to the other, all on far vaster scales than at home, generally increasing the arduousness of the task committed to the engineer. Adapted to the second case to which we here allude, a remarkable structure, that of the Great Lattice Iron Viaduct of the Busseau D'Ahun Junction of the Montluçon and Limoges Railway, has been cited in these pages.*

It now behoves us to speak of an equally striking erection, though of a different style and class of workmanship, that has been of late planted across a gorge of the Gave, or Gave de Pau, as the torrent is called along the lower part of its course. The Gave rises near the French frontier, and for the first 15 or 20 miles of its course, until reaching St.

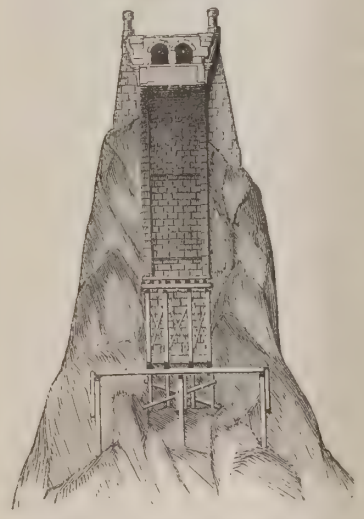
* *Vide ante*, pp. 356–57–58, vol. ii., Third Series.

Saveur, it is a powerful mountain torrent, pouring forth its volume of waters along the rapid fall of its rocky bed. The fall, however, here begins to decrease until Pau is reached, and approaches a gentle incline gradually until the waters debouche into the sea at Bayonne, passing Orthez on the way. On account of the gorge through which these waters pass forming so large a receptacle for the melting of ice and snow from the high Pyrenees of the French frontier, the volume of water is so much increased during the winter season, and also whilst the thaw goes on, as to render the conduct of engineering operations in their locality almost impracticable, and necessarily fraught with a maximum of risk.

In recent times, however, a vast system of highways has been spreading over France, and, amongst others, the Imperial Highway, No. 21, has been constructed, connecting Pau with St. Saveur, in the department of the Hautes Pyrenees. Not many years since the road proper terminated at Pau, and probably at the present time would have extended no further, but for the fortunate sojourn of the Emperor Napoleon at St. Saveur, who in 1859, during a visit to the High Pyrenees, made himself acquainted of the advantages that would be consequent on extending the great highway across the Gave to St. Saveur. He then ordered the road to be continued from Pau to the latter town, a part of which is carried aloft on the stately arch forming the principal subject of this paper.

The character of the bridge itself will be gathered from the illustrations. Fig. 1 is a side elevation of the structure; and fig. 2, a transverse sectional elevation, through the centre of the single arch of which the bridge consists, the clear span of which is 42 metres, whilst the total length of road surface between the abutments is 66·20 metres. This is accounted for by the widening out of the chasm as it proceeds upwards, so that there is a huge mass of masonry on either side the arch, tapering upwards to about 40 feet wide at the road level. The carriage way is 4·50 metres wide, which is bounded on either side by a causeway 0·85 metres in breadth, making the total width between the parapets = 5·35 metres. The footways are carried upon short and deep cantilevers in stone, thus allowing them to project beyond the main structure, and are finished off with a massive cast-iron parapet, corresponding in style to the rest of the work.

Fig. 2.



The cost of the bridge finished was in round numbers very nearly £13,000—more correctly, 318,636f. 97c.; but to enable the bridge proper to be erected, certain temporary works, such as the timber centering, a service bridge, scaffolding, &c., were necessary, these costing 121,092f. 23c. The following table represents the costs of the different works engaged upon :—

SCHEDULE OF TEMPORARY WORKS.

Name of each Division of the Works.	Cost. Francs.	Centimes.
Foundations for the central perpendicular frame, .	7,292	80
Platform at springing level, ...	3,819	47
Centering and framing, ...	38,905	97
Temporary service bridge, ...	12,050	75
Centering for the vaulting of the haunches, . .	1,703	24
Bolts, nuts, and fastenings, ...	8,533	40
Engineers and managers' expenses, ...	24,077	87
Total, ...	121,092	22

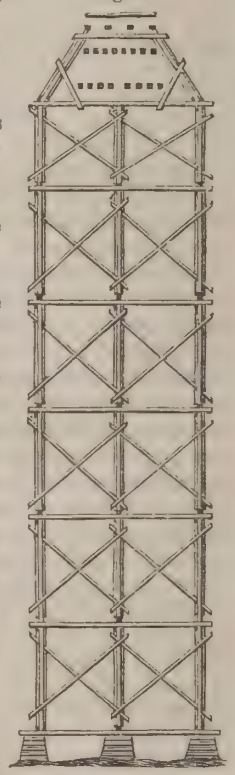
The emperor's orders for the construction of the arch were given in 1859, and the conduct of the whole was vested in the bureau of the minister of Agriculture, Commerce, and Public Works; the work being contracted for by MM. Gariel and Garnuchob, whilst the engineers were MM. Scherer and Marx, ingénieurs des Ponts et Chaussées, the resident engineer being M. Bruniquel, ingénieur ordinaire des Ponts et Chaussées.

The spring courses of the semicircular arch are bedded in the rocky sides of the mountain chasm, at a height of about 40 metres from the summer level of the surface of the Gave waters, and the roadway surface is 66 metres above that level.

The gorge crossed by the arch is one of those deep rents of which the Pyrenees present so many examples, not unfrequently of a mile and more in depth; diminishing downwards, and terminating often originally in a very acute angle, the lower parts of which have in time become choked up with debris and boulders, avalanches, and rock fragments, precipitated from the surrounding summits; the geological formations through which the torrent roars along being chiefly the great tertiary limestone which presents such prominent features in those parts of Europe, intermixed with clay slate and schistose rocks.

The site having been fully settled upon, the first operation to enable the carrying out of the designs was to clear a platform to secure a firm foundation for the six principal timbers of which the scaffolding was composed, and which are shown at fig. 1, and in the transverse elevation fig. 3. This is stated to have been an operation of considerable difficulty, on account of the rush of the waters arising from the melting of the snow and the heavy rains which fell, at the same time the dangers were increased on account of the unreliable material forming the bed of the stream.

Fig. 3.



Ultimately the principals were got in place, and they were rendered more stable by the diagonal bracing carried from the very bottom to the top of the scaffolding; whilst additional rigidity was obtained by several very strong struts formed of whole trunks of pine trees, whose lower ends were imbedded in blocks of rubble masonry, held together by good hydraulic mortar. This central scaffolding ends at the level of the spring courses of the arch, and on its top some transverse horizontal members were bolted, whose ends projected beyond the width of the scaffolding, for carrying a platform, the outer ends of which rested upon similar horizontal members, carried by six sets of diagonal struts springing from the faces of the gorge, these being held therein by bolts and nuts in seats cut into the rock for their reception. The framework of a very rigid platform was thus obtained, and the planking was afterwards bolted and spiked down upon it. The reason for forming this platform so much wider was to fulfil the purpose of a service bridge at both the up and down stream sides of the work.

The centering was next got into place, and it consisted of four main semicircular frames, all parallel and similar, each of which was trussed. Two courses of horizontal ties, as well as the hanging and radial stays, held them firmly together, all the joints being made by bolts and nuts only. Whilst the centering was going on, the stones for the arch were being prepared from the firmly bedded schistose rock which was quarried in the vicinity of the works, the outer rings consisting of wrought ashlar voussoirs, but the interior of coursed rubble ashlar. The first courses were laid on the 15th October, 1860; the ring of the arch completed up to the courses at 60° from the spring course between the 5th and 15th November, so that the arch was keyed and the centering struck in a month from the latter date, namely, December 16th of the same year, so that only about two months were occupied in building the arch itself. In June, 1860, the work was commenced, and in June, 1862, the bridge was open for traffic.

Altogether, the difficult character of the works being considered, the rapidity with which they were executed, as well as the ingenious devices adopted for the erection and securing of the scaffolding, platform, and the securing to the rock the strutted cantilevers on which its ends rested, and the manner in which these were afterwards unbolted, as well as that by which the struts and scaffolding were withdrawn without accident—there appears much praise due to the engineers who designed and carried out the works. The bridge is illustrated at the Exhibition by a very beautiful model on the scale of $\frac{1}{25}$ of full size.

We must not omit to add, that as soon as the centering was well secured, a temporary bridge was constructed over it, carried from the arches of the centering by upright posts, braced together by timber cross stays to increase their steadiness. The chief portion of the work consists of scabbled stone, the ashlar rings, imposts, and cornice, as well as the brackets, or consoles under it, being the only dressed stone used. The ring of the arch, nearly 4·5 feet thick at the key, is set in cement mortar, composed of the Vassy cement and sand; the work of the jointing having been so carefully done, that after the centering was withdrawn the settlement (observed) did not amount to more than 0·20 of an inch, which for so large a span is remarkably small. On withdrawing the centering it was blocked off from the supports by oak wedges, and screw jacks for releasing it were placed under the principal points of support; after which it was removed, leaving clear space under the arch down to the level of the platform at the spring courses.—V. D.

ON SOME POINTS OF PRACTICE IN IRON FOUNDING.

No. XVII.

In our last paper we trust we were enabled to make clear, once for all and for the future, that the notion of the alleged improvement in the quality of the metal of castings due to repeated melting and pouring of the metal "just *thirteen* times," is a fallacy derived from the illogical interpretation of experiments which prove something wholly different. It may be well to add that, in certain respects, every fresh melting of cast iron is attended with a positive deterioration of the quality of the metal, under almost any of the circumstances in which its fusion usually occurs in practice.

In common with all other oxidizable metals—lead, for example, which, as is well known to plumbers, becomes "hard lead" from having been originally "soft pig lead" merely by being repeatedly melted, and getting oxide (litharge) mechanically mixed up, and *possibly* in some way *combined* with the metal—so with cast iron. Every melting mixes it up with more or less finely divided oxides and silicates, in addition to which the earths, which are met with in the materials of the furnace, the fuel and the flux, often get reduced, and their bases in minute quantity alloyed with the iron. The conjoint effect of the foreign bodies and diffused oxides is to prevent the metal running "clean" in the moulds, or making sharp, sound castings; and the effect both of the diffused oxides and of the alloy with the metals of the earthy bases, is frequently to sensibly impair the ultimate cohesion of the cast iron.

These evils are *masked*, or rather *may* be occasionally masked, by the increase of hardness—the approach towards white cast iron—which is produced by each successive cooling; but the combined effect is not that of improvement in the metal as a structural material, but a deterioration; for although it is (as is well known) a fact that the ultimate cohesion of white cast iron is much greater than that of grey or darker-coloured metal, its coefficient of extensibility at rupture is a great deal less; in other words, the white cast iron is stronger, but not so tough.

For these reasons, as well as others affecting the facility and perfection with which hard white cast iron is moulded, it is to mislead the practical iron founder to tell him that the oftener he melts and casts his good pig iron, up to "*thirteen* times" at least, the better it becomes. In brief, the facts are these:—1st. Every additional melting of cast iron injures, or is likely to injure, its quality as a structural material by the addition of foreign substances. These reduce the value of the coefficient of resistance at rupture, and may or may not reduce that of ultimate extension—*i.e.*, the metal, by re-melting, becomes weaker, and may become more brittle. 2nd. Every additional cooling after melting increases the hardness, density, and coefficient of resistance at rupture of *the metal as last melted*, but constantly decreases the coefficient of ultimate extension—*i.e.*, the metal by re-cooling becomes stronger, but more brittle. The limit to these effects is found at the point where the whole of the cast iron has passed into the state of *white cast iron*, as it is produced in "the chill," or in the "finery ingot." The effects are more rapid as respects the *melting* in proportion as foreign bodies, having more powerful affinities and in larger quantities, are presented to the cast iron in the furnace—we may add also, as the nature of these bodies shall be more or less injurious when combined therewith; and as respects the *cooling* are more rapid in proportion as the rate of cooling is more so. 3rd. The conjoint effect of repeated and alternate melting and cooling thus may or may not result in a material possessing a higher coefficient of ultimate cohesion at rupture, but will always result in one more brittle, and thus of less in place of greater structural value. As respects the properties of the material in the iron founder's view, its moulding properties are *always* deteriorated. 4th. If the cast iron *at the commencement* be assumed to be very bright grey mottled iron, or white iron, then it is certain that the effects of every subsequent melting (under the ordinary conditions of cupola or air furnace, to which we have been referring all along) must prove deteriorative, and that only.

We should not have enlarged thus fully upon the subject were it not that the errors with which it has been loaded have gone forth under the sanction of Mr. Wm. Fairbairn's name and justly regarded reputation, have been reprinted again and again by that authority, and have even found their way, either so far without notice, or at least, so far as we know, without question, into some continental works. It is therefore desirable to point out definitely the error of conclusions that are capable of leading to serious practical mistakes.

Before passing to the main subject of the present paper, it may be well to refer briefly to the fact developed in the last—viz., that the density of the same cast iron becomes less in proportion as the bulk of the mass into which it has been cast is greater—with a view to pointing out the physical cause of that which may seem at first glance possibly as a very anomalous result. Nothing, however, is more simple. Every mass of iron which has been cast, no matter what its form, as it cools by conduction or radiation, or both, from the liquid state, consolidates first upon the outside. The solid exterior shell of a mass cooling in repose, which first becomes solid, has had *its* dimensions fixed by the bulk of the still liquid portion of the mass which it contains; but as layer after layer of solidified metal is added to the interior of the external shell, thickening its walls as cooling proceeds, each such layer has diminished in volume by the amount due to its coefficient of cubical contraction through the range of temperature through which it has fallen between liquidity and solidity. The effect of the contraction is to produce internal constraining forces in each such layer in three rectangular axes. The form of the mass *may* be such as to permit more or less molecular movement in all three of these axes; but in general such movement is chiefly, if not wholly, confined to those axes which are normals to the contour of surface of the whole mass, or to the layer which is parallel thereto. Finally, when layer after layer has cooled and solidified, so that the mass is solid to the centre, the *total effect* of these internal strains due to contraction is divided between a hollow cavity formed at the centre of figure—*i.e.*, the well-known "draw" of the iron founder, which represents all of movement that has been transmitted inwardly from layer to layer in cooling—and a certain amount of residual, elastic, molecular constraint upon all the particles, which is divellent in character, inasmuch as it is a constraint which has prevented the particles approaching each other to their respective positions of entire equilibrium of molecular repose at solidification. But for the unit of volume in any given material, particles thus held asunder obviously represent a body of diminished density.

If we have been able to make the explanation intelligible, it will now be plain that the diminished density in relation to increased bulk is a consequence of internal constraints due to contraction in cooling and consolidation; and that as the larger the volume of the casting for a given form, the greater is the total amount of its cubic contraction, so, within certain limits as to size, are the constraints greater, and the reduction in density greater also. We say within certain limits, because, were the metallic mass enormously increased in volume, it is easy to see that the cubical flexibility of the material would sooner or later come to neutralize constraints in all cooling *couches* below a certain depth from the surface.

It follows from the explanation which has been given that *form* is one of the conditions efficient in varying the amount of reduction of density for a given volume of casting; that those forms which produce greatest internal constraint will for given volume result in the greatest reduction of density; and that the *sphere* is of all others that in which such reduction, under a given volume, should be a maximum.

Accordingly, it has long ago been observed that cannon round shot, especially when cast (as was always the practice in old times) in iron moulds, continue, when they have been cooled to the temperature of the atmosphere, for a long time after slowly to alter their dimensions, and

to decrease in volume. This decrease is sufficiently sensible with the common "calibre compasses," or callipers. It is due simply to the slow readjustment of equilibrium between the internal particles which had been held more or less apart by the constraint of their adherence to the interior of the solid shells, successively formed from the exterior of the ball by cooling, as that advanced towards the centre of the sphere, which last became solid.

Conversely, it has been remarked that cannon shot, heated to redness several times (as for firing hot shot), increase *permanently*, *i.e.*, for a very long time after, in volume. Here the very same description of molecular constraints are brought into play, but with the signs of all the forces changed, *i.e.*, all in opposite directions; and the result is a diminution of density, as in the case of cooling from the liquid state.

We now shall pass to the immediate subject of the present paper—chilled iron. Although, as we have stated, white cast iron is structurally of much less value and importance than grey or mottled iron, yet white cast iron has nevertheless its valuable uses, and to these we now turn in making some observations upon the subject of "chilling," or "chill-casting," which is that method of moulding and casting by which, superficially at least, and to a greater or less depth, the surface of a casting made of certain qualities of cast iron can be *at once* converted into white iron. Cast iron as it occurs in commerce, it is scarcely necessary here to repeat, is a highly compound body, and one of a somewhat complex molecular constitution. Not only does it contain various alloying metals and certain metalloids, as well as carbon, but, as Dr. Graham has recently proved, it holds, wonderfully locked up within its mass, several times its own volume of certain gases. Amongst the eight or ten substances that *may* be present in cast iron of commerce, four, viz., sulphur, phosphorus, manganese, and carbon, are those which usually play the most important parts in modifying its properties. At ordinary cold temperatures the carbon in cast iron, at least, if not in every other known form of commercial iron and steel, has been proved long since, by Karsten, to exist in two different states, viz., in 1, combination, and 2, in diffusion; so that *in the cold state* pig iron may have the whole or almost the whole of its carbon in chemical combination with the iron, or with it and with the other metals alloyed with it, or it may have a large proportion of the whole diffused through its mass in the shape of scales of allotropic carbon or graphite. In the former case the cast iron is white almost as silver, intensely hard and brittle, with a strong tendency to develop into large crystalline arrangement. The capacity of cast iron to retain carbon in combination appears to depend in some degree upon the presence of manganese in combination also. Two definite combinations of carbon in pig iron have been recognized, and probably several others exist. These give a percentage of carbon of 5 per cent. and 2½ per cent., respectively. When manganese is largely present, the amount of combined carbon, as in the now well-known German *spiegel eisen*, the *fonte miratoire* of French metallurgists, may rise up to 10 or even a highter percentage. Ordinary commercial pig irons, however, seldom rise above 5 per cent., if so much, of combined carbon. The chemical compound may be, therefore, represented atomically as either Fe_4C or Fe_8C, or some mixture or combination of these; and as regards the matter we have here in hand, it is unimportant to us to consider whether or not it be the fact, as is very probable, that iron unless combined with manganese is incapable of holding these proportions of carbon in combination.

It may be true that Fe_4C can only exist as $(Fe + Mn)_4 + C$, and that probably is so, although the lower compound Fe_8C, and others still poorer in carbon, do appear capable of existence independently of manganese. Recent researches have rendered it probable that carbon, even when in combination, possesses two different allotropic states, and that in one of these it is combined with the iron (and other metal bases) in white cast iron, and in the other in cast steel; and that from this arises the remarkable fact, that though the proportion of carbon in combination be almost or quite the same in both, and that the physical properties are so nearly identical in both bodies when cold, yet the steel may be hardened by sudden cooling, and softened again—in a word, may be "tempered," whereas sudden cooling adds nothing to the hardness of white cast iron.

Such white cast iron forms one end of the scale of commercial pig irons, of which the other is found in those dark or dull grey irons, more or less "keeshy," as the founder calls them, of which No. 1 Scotch pig, and various pig irons of South Wales, are the types. In these a very large proportion of the carbon present is not in combination, but merely in diffusion as scales of graphite. These are either large and shining, and the crystalline texture of the metal is large also, or they are very minute, so that though shining the fracture of the metal is fine-grained or even dull.

Such are the extremes as they present themselves *cold*, and between which are all possible varieties of grey and mottled cast irons. But in the state of liquidity by fusion, the whole of the carbon in both alike must exist in the state of combination. This is demonstrable, for as the specific gravity of the cast iron is, say, seven and a fraction, while that of graphite in scales is only 2·35, or thereabouts, if those scales pre-existed in the fluid metal they must have all floated up to the surface, and so separated themselves. They were, therefore, formed from the carbon of combination by segregation of a portion thereof during the moment of solidification of the liquid iron, and in the act of segregation assumed the new or allotropic condition as graphite scales (crystalline plates probably), and this segregation must have occurred *at the instant of solidification*; for otherwise, on the grounds already stated, the scales of graphite could not have remained uniformly diffused. In this way, it may be broadly stated, no cast iron can be cooled from fusion without such a segregation of combined carbon taking place, and presenting itself in the form of graphite.

The proportion of the total of carbon present in the liquid iron that shall thus be segregated out at cooling depends, no doubt, upon many and complicated conditions, into which we need not enter here at length. Amongst these, the presence of manganese in greater or less proportion is probably one of the most important. Unless that be present in the iron in appreciable quantity, it does not appear that any compound of iron and carbon can be melted and cooled without the segregation of a considerable proportion of carbon, and the more as the rate of cooling (other things being the same) is slower. This power of holding the combined carbon still in combination during the cooling of the metal, is one of the important functions of manganese as entering into the constitution of cast steel. As this process of segregation of combined carbon into graphite goes on every time a cast iron is melted and cooled to solidity again; and as the graphite scales once formed in the mass are not re-combined, or are so in but a very partial or local manner, during the process of melting over again the same cast iron, but are deflagrated and burnt out and volatilized in the cupola or furnace—so at each melting, with free access of air, cast iron is thus deprived of more and more of its carbon.

This is what has gone on in the re-meltings already referred to of Mr. Fairbairn's experiments, and it is what forms the basis of the operations of the "refinery," for producing white pig iron from dark or grey, as an intermediate process in the manufacture of malleable iron.

Thus, white cast iron may be obtained by any one of three methods:

1st. By rapidly cooling the whole of a very thin slab of gray pig iron, which, however, must not contain more than a determinate residual portion of suspended graphite. This is the process of the refinery. The suspended graphite, which has not been burnt out, is *extruded* and brought to the surface by the rapid formation of the crystals of the iron; and it may be noticed in passing that such dark grey pig iron as proves ill suited to the operations of the "finery," owes that unsuitability in great part to the fact, that it contains so much carbon that the quantity of graphite segregated in the sudden cooling is larger than the crystallizing metal is able to eliminate and separate from its mass.

2nd. By alternate melting and casting, with the ordinary rate of cooling, as referred to already. This, as has been said, is only doing "refinery" work in a slow and incomplete manner.

3rd. By working the blast furnace *en surcharge*, that is, with an excess of ore and blast in proportion to the amount of fuel. This is the method by which the white mottled iron, which is employed in Sweden for casting guns, and is known to the Germans as "Weissgefleckte's Roheisen," is made. This constitutes, in fact, an indirect method of burning out the carbon down to a point at which, even at the ordinary rate of cooling, graphite scales are segregated in very small quantity and in very minute division.

Having pointed out the two conditions in which the carbon exists in cast iron, the modes by which its amount in combination in liquid iron may be diminished, and the general fact of the extension of the diffused scales of segregated graphite by the crystallization of the metal, whose still combined carbon is reduced sufficiently low that it shall not, at the point of consolidation, segregate more graphite than it is able to at once extrude, we are now in a position to understand the *rationale* of

the iron founder's process of "chilling." The liquid cast iron is here poured directly into a mould, formed also of cast iron usually, but not necessarily, as any good conducting body capable of resisting fusion by the high temperature of the liquid metal, and of not flying to pieces by the sudden heating, would equally well answer the purpose.

The "chilling" when effected consists in this, that the cast iron which, if cast in loam or in a sand mould, would prove, after it was cold and upon fracture, more or less mottled or grey, if cast by pouring it into a "chill mould" shall prove upon fracture still grey, or mottled indeed, towards the central portion of the mass, but converted for a certain depth inwards from all its surfaces of contour into more or less perfectly white cast iron. Now, what has happened to produce this change in both the chemical constitution and in the molecular arrangement of the outer *couches* of the casting, perhaps of its entire mass? We have simply cooled the exterior of the mass by conduction of the cold metallic mould or "chill"—1st, with great rapidity, much *greater* rapidity than if we could have poured it into cold water, which cannot remain in close contact with the liquid and then solidifying metal, as the internal surfaces of the chill do; 2nd, in successive *couches*, all strictly parallel to the internal surfaces of the chill and to each other, which *couches* solidify in succession thus, from the outermost film further and further inwards. The result is that we seize upon a thin external portion of the mass, and compel it suddenly to solidify and to crystallize without parting with any of its carbon of combination. In crystallizing it detrudes whatever scales of graphite were suspended within this first imaginary thin film or *couche*, and forces them inwards, passing them on, as it were, to the next *couche*, which in its turn solidifies, crystallizes, and in so doing detrudes them and its own graphite on to the next, and so on for the entire depth of the chilled portion. Chilling, therefore, consists in the detrusion of suspended graphite from the surface of the chilled casting into the interior of the mass, leaving the metal of the casting to the depth to which chilling has taken place with all its carbon in combination, and as white iron, with the hardness and density of hard steel nearly.

Complex as is the result, or rather the explanation of the steps which lead to it, it is simply due to sudden cooling at the surface, advancing from the surface to the interior.

It has nothing to do with the material of the chill mould, except in so far that this must convey away the heat with great rapidity; and some notions which possessed in former years more or less currency, that the effects were due to some supposed mysterious chemical or other action of the cast iron of the chill upon that which is poured into it, are devoid of any foundation. Anything else that would stand as a mould, and cool the metal as fast as a cast-iron chill, would perform its functions just as well. It happens, however, that no such substance can be found; and hence practically "chills" are always made either of cast iron, which is the nearly universal material, or of wrought iron for some special purposes.

In proof of this being the real nature of chilling, we may adduce the following analytical results obtained by Karsten, and given in his "Eisenhuttenkund Band," i. p. 583:—A certain sort of pig iron on analysis was found to contain 4·0281 per cent. total of carbon, of which 3·2469 per cent. proved to be diffused graphite in insoluble scales, and 0·7812 per cent. to be combined carbon. It was a soft grey iron. When melted on the large scale in an air furnace, and poured and solidified in a chill, it was found chilled to the depth of an inch, and to that depth, or nearly so, as white and as hard as steel; the interior remaining to the eye much as before—grey iron.

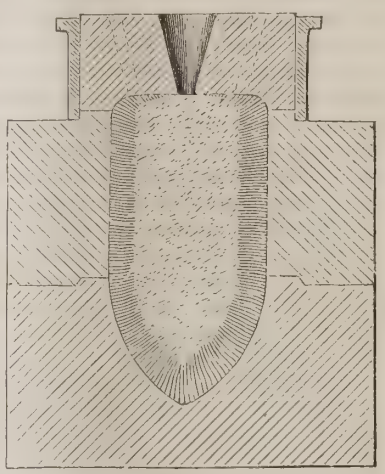
The chilled portion and the interior were now analyzed. The former proved to contain 5·0929 per cent. of carbon, all in combination. The latter contained a total of 3·8047 per cent. only of carbon, of of which so much as 3·1941 per cent. consisted of scales of diffused graphite, and but 0·6106 per cent. carbon of combination. Thus while the pig iron, as at first, contained only 4·0281 per cent. of carbon in all (*i.e.*, in both states), the chilled outer *couche* produced from it contained *more*—viz., 5·0929 of carbon, all in combination, being very nearly that due to the definite chemical compound Fe_4C, while the interior or unchilled portion contained only a total of diffused and combined carbon of 3·8047 per cent.; that is to say, the chilled part had gained in total percentage of carbon, while the unchilled portion had slightly lost percentage of the same. It is probable that in this case, as in almost all in which fusion is performed in the air furnace, the iron had slightly gained in carbon during the melting; and unless we knew the relative volumes and weights of the chilled and unchilled portions of the entire mass cast into the chill, we could not determine how much. But, passing this, the facts sustain what has preceded of our explanation. They indicate that, while in fusion, the whole of the carbon exists uniformly diffused and in combination; that whether the cast iron shall continue to hold the whole of this in combination, after it has cooled, or extrude part of it as segregated graphite, depends *upon the original percentage of total carbon in the liquid state*, less directly upon the accidental constituents of the iron (manganese, &c.), and *upon the rate of cooling*.

The chilled portion, in so far as it is perfectly white, crystalline, and uniform in texture, constitutes a true chemical compound of iron and the accidental metals with carbon, which, in forming, takes from the adjacent metal whatever additional carbon, if any, it may want to satisfy the affinity, in producing the compound Fe_4C, or in other cases perhaps, *i.e.*, with other qualities of pig iron, Fe_8O.

In the above quoted experiment of Karsten, the specific gravity of the pig iron was 7·1839, that of the *interior* of the chilled casting was 7·1753; the reduction being due to the divellent force of contraction to which we have above referred; and the specific gravity of the chilled exterior was 7·5467, or almost the density of cast steel. This great increase of density is the measure of the force of that squeeze by which, from film to film of the fast cooling, contracting, and crystallizing external *couche*, the graphite scales are detruded.

We have already, perhaps, expended too much space upon the theory of this interesting process, though not too much as regards the importance of its clear comprehension; but we must delay a moment longer to notice one more theoretical point in relation to it.

The iron of the chilled *couche* is invariably crystallized; and in accordance with what has been stated in a former one of these papers (No. XVI.), the principal axes of symmetry of the crystals are always arranged in direction perpendicular to the surfaces of contour of the chilled casting. This will be evident to the eye from fig. 1, where an elongated chilled shot is shown in vertical axial section in the chill mould as cast; the upper part, containing the "gaits," &c., being formed of "dry sand." This perfectly symmetric arrangement of the long *axes of figure* of the integrant crystals of the chilled portion of the casting, which, as Savart has shown, are also the axes of elasticity of the crystals, is in some cases, as, for example, in that of projectiles, of practical value. The difference in *hardness* between the chilled portions, when attempted to be cut by a steel chisel in a direction perpendicular to those long axes, and parallel to the same, is very apparent in chilled castings.



If cast iron be already white iron, chilling produces little other change upon it, except this new and symmetric arrangement of crystalline axes. The mass remains white, or nearly white (*i.e.*, with small specks or nests of graphite flecked through its interior here and there), all through; but the exterior is rearranged as to its molecules; and however hard the interior part of such a white-iron chilled casting may be, the exterior surface and for a certain depth is rather harder. Chilling is, however, really of practical value where the object is to unite on the one casting a softer and tough interior of grey or mottled cast iron, with a hard and rigid, though brittle and dense exterior. Thus in the chilled railway points and crossings of cast iron cast in one piece, which are so much in use in Germany, the faces and flanks of the rails or points are as hard as hard steel, and not *excessively* brittle, while the bedplate that unites them all is of fine tough mottled cast iron.

Thus also, as another example, we may take the chilled rollers employed in mining operations for crushing siliceous and other very hard minerals or ores, and those employed in iron works for rolling boiler plate and sheet iron, where the surfaces of the rolls and necks thereof are thus made as hard as steel, while the cores possess the

toughness of the best bearing cast iron. Hard as chilled iron is, it can be turned and cut, or rather stripped or forced asunder, and brought to an exquisitely smooth polished surface, by suitably formed steel tools acting in the lathe. It would be out of place here to go at any length into the special tools and methods which experience has discovered for thus operating upon chilled cast iron. We may, however, just state that a mere cube of the best cast steel, made as hard as it can be made by fire and water, when one of its edges, with its angle of 90°, having one of its sides tangential or nearly so to the face of a cylindrical chilled roller of cast iron, is firmly forced against the latter by a lever, and the roller is caused to revolve in the lathe *slowly*, is found readily to penetrate the hard material, and to remove its substance in short, sharp, wiry, needle-like splinters. These, when so broken rather than cut off, are found to possess frequently powerful magnetism with polarity.

Rollers, or such like, are turned in bearings on their own necks; these being first turned, as the lateral pressure of the tool is severe.

Chilled castings may also be planed, or even slotted, by analogous means, but these are seldom required. Elongated projectiles, if chilled, would be best brought to exact calibre by being forced by the hydraulic press through a ring-formed die of cast-steel tools, held together by properly proportioned apparatus.

To return from this, which is in some degree a digression, however: the *depth* to which chilling can be performed from the surface of the casting depends upon a large number of conditions, but mainly upon the following:—

1st. The metal employed for the casting being of the best possible quality for chilling—*i.e.*, containing just the suitable proportion of combined carbon, and no unnecessary portion of suspended graphite.

And in one word, it may be said that *any* bright grey, rather hard, and mottled cast iron, whose crystals on fracture present small faces, having the above proportion as to carbon, can be chilled effectually; that such iron, when it contains a sensible proportion of manganese naturally, as is the case with many of the German and Scandinavian pig irons, or when the manganese has been introduced to it by adding in the cupola or air furnace a small proportion of *spiegel eisen*, is that which chills best, and gives the hardest, densest, and most uniform surface of castings; and lastly, that there are some sorts of dark gray, or almost black pig irons, surcharged with scales of graphite—such as the *keeshy* No. 1 Scottish pig irons—which for practical purposes cannot be chilled at all; and even when mixed with a large proportion of "hard scrap," these chill very superficially and badly.

2nd. Upon the *mass* of the chill in relation to that of the casting to be made in it.

3rd. Upon the absolute mass of the chill casting itself; for, as may be inferred from principles already stated, if the mass of liquid iron poured into the chill be so great that a very great length of time necessarily elapses before the interior can become solidified and nearly cold, reduced at least below the temperature of clear redness in daylight, the chilling already accomplished at the exterior may be destroyed subsequently by heat communicated to the external couches from the reservoir of heat in the interior. The chilled condition of the exterior is, in fact, removed by *cementation;* the interior of the casting supplying the heat necessary to effect this.

We shall treat more fully of these and certain practical conditions of chill casting in the next, or a future paper.—Ed.

THE PARIS EXHIBITION.

MINING AND METALLURGICAL MACHINERY AND PROCESSES.

CLASS 47.

By Warington Smyth, M.A., F.R.S., President Geological Society.

Universal Exhibitions have trodden so closely on one another's heels, that before we are well recovered from the hubbub and excitement and expense of one great international show, we are called upon to prepare for another. One result is, that many exhibitors in particular classes feel their enthusiasm in the cause is waning, and another, that the advancement in some of the subjects is not likely to be very striking. But the fact of its being brought together in the metropolis of a different country impresses upon the collection a special character, which invests it with a peculiar interest; and those who fairly weigh the circumstances under which the various objects are brought together, will find that much of what was imperfect in the Exhibition in London is supplemented in that of Paris, and *vice versâ*. Thus, as might have been expected, the English exhibitors in the mineral classes found it more convenient to come forward in numbers in our own country, whilst in France they are comparatively in a small minority; and we have, on the other hand, now a better opportunity of becoming acquainted with the products and processes of the continental, and especially of the French works. It is only, therefore, after a careful study on both occasions, that we can form a just estimate of what is doing in the several countries.

The French and Belgian engineers being near their own homes, and dealing with branches of their subject which are comparatively novel among them, have exhibited in full size certain apparatus, such as the coal-pit top, with pulley-frames, &c., from Béthune, winding engines from Creusot and from Chatelineau, and colliery cages from several localities, whilst the absence of similar objects from England would simply show that our coal-owners and manufacturers imagine they have nothing to gain from the exhibition of pieces of machinery of a similar character, which are familiarly known among us. But it is worthy of observation, that whilst a few years ago foreign countries were much behind our own in the completeness and scale of such apparatus, they have now made remarkable strides, and have little if anything to learn from those British works which were formerly the highest standard of excellence. We used at one time to imagine that for heavy machinery the foreigners must needs apply to our English manufacturers, but it is now clear that they can supply themselves; and not only upon old models, but with contrivances showing ingenious modifications, which proceed from a thorough knowledge of the subject. Nay, more than this, the drawings exhibited by M. Quillacq (France, 1 and 27) place before us the construction of a large pumping engine, and of a double-cylinder winding engine, made for one of our Newcastle collieries; and I must add from the testimony of the owners, that these engines were ordered from the works of this maker at Anzin, in Northern France, simply because his tenders were considerably lower than those of the English firms with which he was compared, and that after nearly two year's working the French engines are pronounced to give full satisfaction. This sounds almost like the prelude to the famous feat of sending coals to Newcastle; but whilst nature has been comparatively unkind to the coal seams of the Department du Nord, by making them expensive to get, it reflects great credit on the skill and steady industry of the engineers and workmen, that they should be able successfully to compete with us in the midst of our own workshops.

In the boring of deep holes for artesian wells, and for the exploration of stratified minerals, the French have for many years past been prominent. The great works which have been successfully carried out by the firms of Mulot & Dru, and Degousée & Laurent (France, 58 and 57), are, as it were, reflected in the judicious selection of objects placed by them in the Exhibition. Both of these houses adhere to the system of boring by rods instead of by the rope, employing, when the holes are deep, wooden rods with iron connections; both of them work the rods by means of a lever of the first order, at the longer arm of which the movement is given by a steam-engine; and both have adopted the system of a free fall (*chute libre*) for the cutting tool. The general form of their apparatus is shown in model, some of the rods, tools, and pipes for tubing are there in full scale, and there is also a goodly array of the cores, *carrottes*, of a great variety of rocks which have been brought up bodily from the depths of their bores. Except in minor details, there is nothing new in them since the Exhibition of 1862; but it is a subject of high interest to the miner and to the hydraulic engineer, to observe them with reference to the grand wells which are at present in course of operation, by the former firm, at the Butte aux Cailles, in the extreme south of Paris, and by the latter, in the suburb of the Chapelle, in the north of the city. They are intended, like the celebrated wells of Grenelle and of Passy, to penetrate to the greensand subjacent to the chalk, and thus to supply four quarters of the metropolis with copious streams derived from the feeders of the outcrop of the formation, some fifty or sixty miles distant. It is only on visiting the scene of these undertakings that one can fully appreciate the system and comparative facility with which they are conducted, even when on a scale of which we have no parallel in this country; and that we can do justice to the black tower of iron tubing shown by Degousée & Laurent, with which

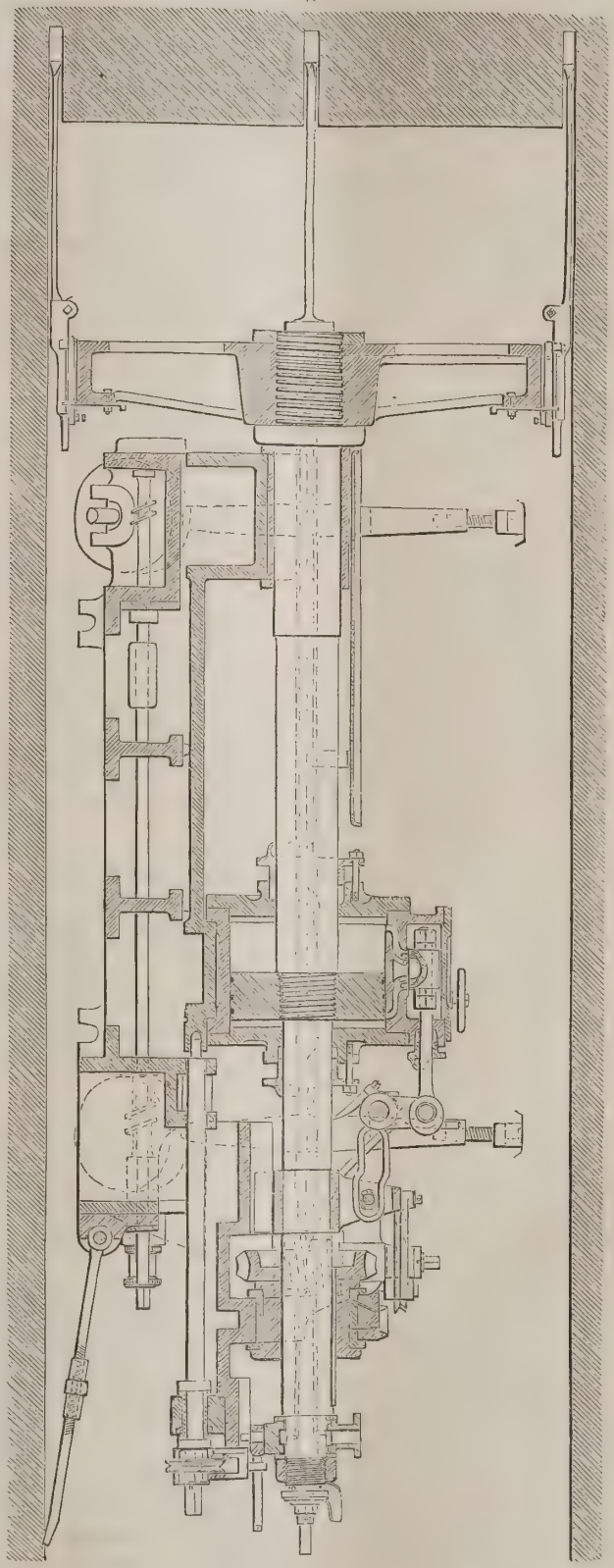
they are lining the hole—we might almost call it the *shaft*, of 1·60 metres (above five feet) in diameter.

In point of magnitude, and of novelty of application, these are far exceeded by the apparatus and drawings, which tell of the successful result of the sinking of actual coal-pit shafts through watery ground in the department of the Moselle, by the company of St. Avold and L'Hôpital (France, 53). Gigantic borers of upwards of 13 feet in diameter are exhibited, and a model shows us how, by the action of the tools devised by Herr Kind, coupled with the introduction of the system of lining proposed by the Belgian engineer, M. Chaudron, the difficulty of sinking a pit down through hundreds of feet of water-bearing new red sandstone has been successfully surmounted. The moss-box, *boite à mousse*, of Chaudron, is a sliding length at the bottom of the tubbing, which is kept suspended whilst the cutting tool is employed continually deepening and enlarging under the base of the lining the shaft which is to receive it. The whole column of tubbing is lowered as the work advances, the pit being kept full of water; and at length, when a firm foundation is reached, and a bed fairly prepared by the enlarging tool, the bottom curb comes to rest, the weight of the tubbing above presses by a broad flange upon some 3 feet high of moss, which is soon squeezed into a very small compass, and a water-tight joint is established, which allows of the water being then pumped out of the shaft, and of ordinary sinking being commenced below. For further security, an additional ring is put in below, resting upon wedging curbs, and the deeper part of the shaft is secured by common brick-work. Pit No. XI. had the wedging curb fixed on the 1st May, 1866, at the depth of 159·50 metres, and the coal was reached at 316 metres deep on the 4th April last; whilst pit No. XII. had the "moss-box" successfully bedded on the 3rd February last, at the depth of 159 metres. Every coal viewer will appreciate the importance of distinct examples of a successful innovation upon the older methods, in these days when it becomes more frequently necessary to sink to coal through overlying formations, and through beds containing water exercising a high degree of pressure.

Taking a glimpse at the long stretch of the coal formation, which extends from Hardinghem, near Calais, with but little interruption, to the important field of Westphalia, it is obvious, that as it is in many parts entirely covered up by alluvial beds, and even by the cretaceous strata, the mining engineers of Northern France, of Belgium, and of Prussia, have during the last quarter of a century served a trying apprenticeship in the art of sinking shafts amid manifold difficulties. They have in most cases adopted a method analogous to that of our northern districts, viz., that of setting to work a powerful force of engines to pump water until impervious beds are reached, and then fixing a wedging curb, and building the tubbing upwards. Most commonly the use of oak blocks has been preferred to cast iron for this purpose. But in several difficult cases of late years, where every attempt to take out the water was followed by inroads of quicksand, the mode of sinking *à niveau plein* has been adopted; *i.e.*, the shaft has been bored out like a gigantic bore-hole, by cutting and bagging implements used under water; and a tubbing, constantly added to at the surface, has been lowered as the depth increased. The great desideratum was the final fixing of the bottom of the tubbing in such wise as to form a water-tight joint against the strata; and this has been more or less fully accomplished by various methods, but by none, as it would seem, so satisfactorily as by this plan of Chaudron's. At the Exhibition of 1862 it was exhibited as a scheme that had been practically tested in one or two instances; but it is now brought before us with much higher claim to attention, from its having been brought into play with perfect success in the sinking of several pits upon that prolongation of the Sarrebrück coal-field which had been proved by borings to extend from the Prussian into the French territory.

In the department of the laying out of mines and collieries, the Exhibition is fragmentary and unequal. But a great deal may be learnt from some admirable plans and models which have been contributed by the Sarrebrück coal-field, and by several of those of France. A most elegant model in glass shows the position and workings of the Prussian deposit of rock-salt at Stassfürth; and some beautiful things have been sent from the old established mines of the Hanoverian Hartz, now figuring as "annexed" territory. The French collieries of the central and southern districts, particularly those of Blanzy and Montceau, of the Commentry Company, and of St. Etienne, have all of them one general lesson to teach, viz., that where the seams are of exceptional thickness, as from 30 to 60 feet, the most approved mode of getting the coal, with due regard to the security of the men and to general economy, is to work it in horizontal stages, where the openings are systematically filled with *remblais*, or rubbish brought down from the surface specially

Fig. 1.



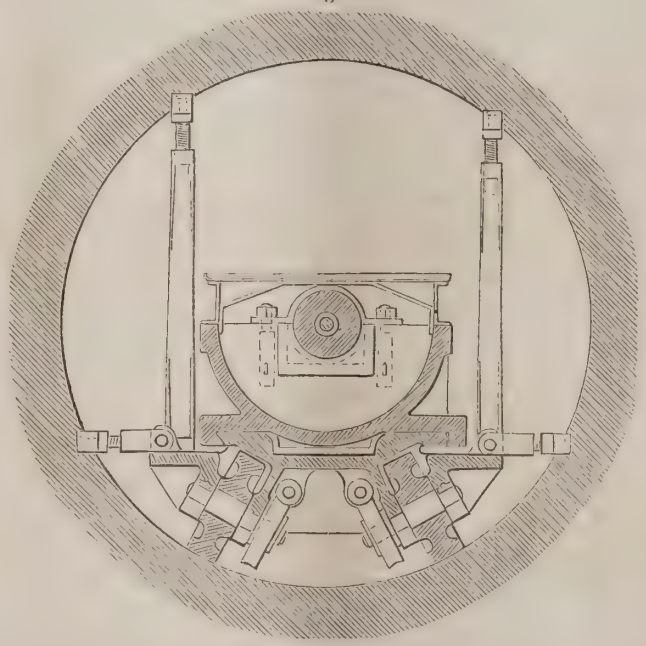
for this purpose, and packed by men who work during the night, when the colliers are absent from the mine.

In most of the important mineral districts the question of the substitution of machines for manual labour has for several years past been attracting much notice. From the United States, where the high rate

of wages renders this a matter of prime importance, the "Steam Stone-cutter Company" have forwarded a machine which is stated to do excellent service in the extensive marble quarries of Vermont. It is the invention of Mr. Wardlaw, who has patented it for France and England. A carriage of 6 feet in width is propelled by an engine of 4 horse-power along rails laid upon the surface of the stone which is to be cut into blocks. On either side of the front of the carriage is a series of heavy bars armed with cutters, which are made to rise and fall in line, and which, as the machine advances, cut grooves of the requisite depth, and a few inches wide, which shape out the stone in the dimensions of the blocks required. These are afterwards riven off by wedges in the usual manner; but the substitution of the machine-made groove for the laborious and more wasteful cut ordinarily made by picks is said to have been accompanied by very great economy.

For the horizontal and inclined holes required for tunnelling and mining the conditions are more difficult. It will be remembered that Captain Penrice, R.E., and other inventors have proposed, and even constructed, machines for the hopeless task of cutting away the hard rock bodily, without the use of powder. In the present Exhibition the necessity of employing an explosive compound to blast the holes is in all but one case fully recognised. Captains Beaumont and Locock, R.E., exhibit in the English machinery department a powerful machine (represented in longitudinal and transverse section at figs. 1 and 2),

Fig. 2.



intended to work out the whole area of a circular drift, and driven by compressed air. A horizontal cylinder, placed on a heavy carriage, has, attached to a stout piston rod, a strong iron wheel, facing the rock which is to be attacked. On its periphery it carries a series of six-and-thirty borers; and at its centre, one borer of rather larger diameter. The object is thus, by a succession of rapid heavy blows, whilst the whole wheel with its cutters is in slow revolution, to cut an annular groove in the face of the rock; and a central hole, which, when the machine has been backed from the place of work, is charged with powder. The explosion is then to blow off the rock down to the depth of the central hole and the groove; and after the debris has been removed, and the face of rock squared up, the machine will be brought forward again to recommence its boring.

More suitable for actual mines, where space and economy are prominent objects, are the various efforts which have been made to produce a simple machine capable of boring a single hole at a time in any required direction. First among these should be mentioned the machine of Mr. Dœring,* of Ruhrort, in Westphalia, one of a series of contrivances more or less founded upon the system successfully applied by M. Sommeiller in the Mont Cenis Tunnel. It is naturally to be expected that in the outset of endeavours to resolve a difficult problem many mistakes should be made and failures encountered. Let inventors beware of the idea that it is sufficient to devise an ingenious machine which will go through all the motions required. The circumstances under which it has to be employed are often so peculiar, and the conditions of a mine in general so unlike those of an ordinary workshop in the upper air, as to make it no subject of wonder if many of the so-called boring machines tried within the last ten years have been a source of loss and vexation to all concerned. Mr. Dœring's, however, comes before us as a recognized "effective" in the *matériel* of a mine. At the celebrated zinc mines of Moresnet, belonging to the great Vieille Montagne Company, no less than eleven of them have been in operation for some time past; and I have it on the direct authority of the well-known and experienced manager, M. Max Braun, that in a level where six men used to drive, in hard dolomite, barely 5 feet in a fortnight, two men with the boring machine can accomplish in the same time 10 feet, and sometimes even more. The drilling engine itself is a small and light piece of apparatus, including the chief compressed-air cylinder for projecting the borer, and two smaller cylinders also worked by air, one for turning the borer after every stroke, the other for advancing as the hole deepens. It is mounted upon a horizontal arm, which can be made to traverse up and down an upright column forming part of an iron carriage, the weight and means of fixing which give the requisite stability during the operation. The drill or borer (which is preferred of the reversed Z shape used at Mont Cenis) is, by means of pivoting and sockets, capable of being made to act in any required direction; and as a jet of water is continually squirting into the hole for the removal of the sand, the machine, when once set, is capable of doing its work with wonderful rapidity. In the experiments, from 1 to 1½ inches deep in hard granite has thus been bored per minute; and it would appear that from the different nature of the blow, as compared with hand-boring, the bit or sharp edge will stand much longer than it does when struck in the ordinary way by a mallet.

Another machine of the same class is that exhibited by M. Bergström (Sweden, 1), stated to have already worked 700 days in the mines of Persberg, and to have proved its ability to bore in granite no less than 6 feet deep in an hour. The whole apparatus weighs only 120 lbs., and has been arranged with a view to easy removal and fixing in the small galleries of mines. The boring cylinder and its gear are made to traverse up and down a stout bar, parallel to which only can the drilling tool be made to work; the guide bar is therefore provided with screw hitches, and must be fixed by means of timbers wedged across the level in the direction parallel to which it is intended to bore. This *bergborr maskin* appears to be a modification of that of Schumann, of Freiberg, is worked by compressed air, making on the average about 350 strokes per minute; and from the actual driving which has been done by it in stiff ground at Persberg, coupled with its convenient portability, is entitled to consideration as something more than an ingenious project.

From the United States a "perforator" has been sent by General Haupt, the general features of which are somewhat comparable to the two last, although modifications of much ingenuity have been applied. One or more of these perforators may be mounted on a frame of two strong vertical pillars, to be firmly hitched by their steel points, screws, and jam-nuts. The single drilling part weighs 125 lbs., the stand 180 lbs.; and thus, if more than one machine be used at a time, the weight of the whole would render it so inconvenient as to be inapplicable for common mining. In its simplest form it may be pronounced to promise well; but we look in vain through the descriptive pamphlet entitled "Tunnelling by Machinery," which has been prepared in explanation of the machine, for a statement of actual work performed by it. Great glorification of General Haupt, in a style that would appear to our old-world notions to be in bad taste, little or no mention of other inventors of similar apparatus, Sommeiller excepted, and a curious mixture of results of experiment with mere projects, leave the reader in much uncertainty whether or not the machine has been really applied. The General is a strong advocate for the use of steam as his moving agent, in opposition to compressed air, as used at Mont Cenis, and would bring his boiler very close to the place of work; but notwithstanding his arguments, and the reference to experiments in the Franklin Tunnel, we are very doubtful as to the soundness of his conclusions.

There is yet another drilling machine (France, 49 and 73) exhibited by the company of the Chemins de Fer du Midi, consisting of a rotatory borer, worked at great velocity by a horizontal water-pressure

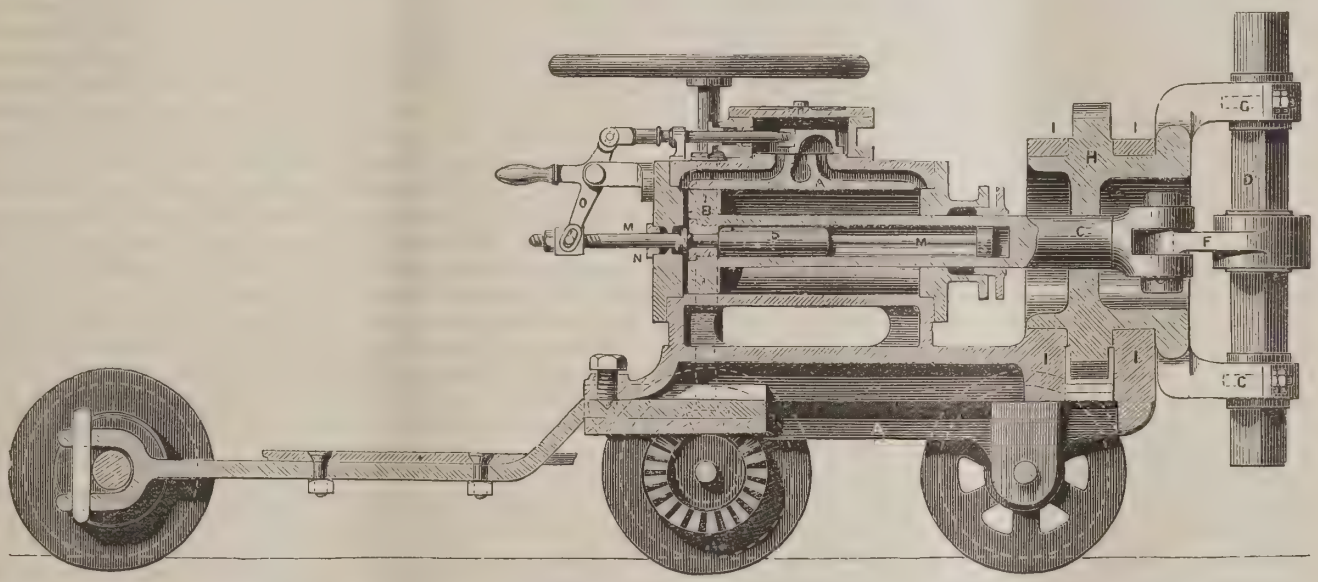
* This is at present (May, 1867) to be seen in action at Felix Street, Westminster Road.

engine. Drills of various form have been employed for experiment, but the best and apparently only practically sufficient results in hard rock have been obtained by the diamond-studded borer of M. Leschot. This is an annular drill, the end of which, of soft iron, has eight pieces of black diamond set in it; whilst through the tubes in the middle a jet of water plays into the hole. From the hydraulic machine a pressure is kept up on the base of the borer, which in the hardest stone need not to exceed 1540 lbs.; and it is really surprising to see the rapidity with which a hole is thus bored in dense marble, or even in quartz rock, leaving a thin core in the centre, which is readily broken off and taken out from time to time. The diamonds are, of course, but refuse stones as regards jewellery, and cost about 170 francs for one boring tool; whilst the great hardness of the gem enables it to grind away the rock with so moderate a loss of its own substance, that it would appear, from the statements made, that the wear and tear of the diamonds for a single hole of 20 inches deep would cost less than 2½*d*. Not reckoning the prime cost of the machinery, the result of a number of experiments is said to be that the running metre (3·28 feet English) of hole in ground which it would cost 5*s*. to bore by hand, would by this means cost only 1*s*. 3*d*. And although the inventors make no pretence to have proved the result on the large scale, they estimate that a gallery may thus be driven with a saving of 15 per cent., and that if a natural pressure of water be available, it would even amount to as much as 40 per cent.

In no other country than our own do successful attempts seem to have been made to grapple with the problem of cutting coal by machinery; and nowhere in Europe do they promise to bear such valuable fruit as here, where, on the one hand, a larger proportion of hard coal exists, which it is a sin to cut into slack, and where our coal-owners are so often hampered, on the occurrence of strikes, by a lack of hands. After many projects had been devised, and a few of them vainly tried, Messrs. Firth, Donisthorpe, & Ridley, about six years ago, constructed a machine to hole or undercut the coal, which has been worked at West Ardsley, near Leeds, and at Hetton with great effectiveness.

Messrs. Jones and Levick, of Blaina,* now exhibit (United Kingdom, 8) an important modification of that machine, with the engine for compressing the air by which to work it. A strong iron pick is carried in a revolving head-stock, which is capable of being turned into any desired position by turning a hand-wheel at the end of the machine; and thus it may be made to undercut the seam, when it either dips or rises away from the tramway on which the carriage moves. If necessary it may be even placed vertically, so as to shear or cut the coal in that direction also. The pick being flat, and working with great regularity, cuts a groove 3 feet deep, which is only 2 inches high in front, and 1½ at the back, whereas, by the common method, it would be 10 or 12 inches high in front. A great economy is thus effected when the boring, as is usually the case, is made in the coal. As regards speed, it will hole to a depth of 3 or 3½ feet a length of from 9 to 15 yards in an hour, the number of blows being sixty to seventy per minute, and

Fig. 3.



the pressure of air 30 to 37 lbs. It is hence estimated that, when fairly set going, the machine will do the work of twenty colliers. In certain seams of coal, particularly in those of great thickness, the holing might have to be conducted in a different manner; but the facility of placing a pick at any requisite height, as well as altering the angle, give this machine a great power of adaptation to different circumstances.

We have received from Mr. Levick the following description of his improved machine, which is shown in longitudinal section in the annexed engraving, fig. 3. A A is the cylinder and bed, which are cast in one piece; B is the piston and C the piston rod, which is forged solid in one piece with the piston; D is an axis to which the pick is affixed; F, a crank arm on the axis, D, to which the piston rod is attached by means of the slotted head screwed into the end of the piston rod, as shown; G G are bearings of the axis, D, cast on the hollow bearing, H, which is capable of being turned on bearings, I I, by means of a hand-wheel fixed on a shaft, on which is a pinion, taking into teeth on the hollow bearing, H. It will be seen that by turning the hand-wheel the hollow bearing, H, will be caused to revolve, carrying with it the pick axis, D. This axis, when it is desirable to vary the direction of the action of the pick, can be locked in any desired position by means of a lock nut on the end of the shaft.

The valves of coal-cutting machines heretofore constructed have all been worked by the hand or the foot. This, as in the case of the steam hammer, has been indispensable, on account of the length of the stroke constantly varying. In coal-cutting machines, for instance, when a blow is struck it is impossible to tell how far the force of such blow will cause the pick to penetrate the coal; consequently you cannot arrange any of the known systems of valve gear to act so as to bring the pick back again. This difficulty has now been entirely overcome by the valve gear used in this machine. L is the slide valve by which the compressed air is admitted to, and allowed to escape from, the cylinder. This valve is worked in one direction by the piston, when completing its back stroke, striking against the collar, A^1, on the rod, M, which works through a stuffing box, N, in the back cover of the cylinder, and is connected to the lever, O. The piston rod, C, has a long hole bored in it to receive a plug, P, which is capable of sliding freely on the rod, M, which passes through the cylinder cover, and is connected to the lever, O. The other end of the rod has a stop, S, fixed to it. When the piston is moved in the direction shown by the arrow to strike the blow, the plug, P, is carried with it, and if the piston completes its full stroke, the end of the plug comes in contact with the stop, S, and reverses the valve; but should the piston stop short of the full stroke, owing to the force of the blow not being sufficient to penetrate the coal to the full extent of the stroke, the plug, P, by the impetus it has received, slides forward and strikes the stop, S, and reverses the valve, L; the piston is then brought back and comes in contact with the collar, A^1, on the rod,

* Our readers will find an illustrated description of Messrs. Jones & Levick's machine at page 245, vol. i., Third Series.

M, and reverses the valve again to repeat the blow. The machine is moved forward by the hand-wheel, Y, which communicates motion by gearing to the wheels upon which the machine travels.

Messrs. Carrett, Marshall, & Co., of Leeds (United Kingdom, 3) have exhibited a machine intended for the same purpose, but worked by hydraulic pressure, and cutting the groove by the steady action of a long rod armed with scoops, which plane off slices of the coal from the front towards the back. The whole apparatus, when the stroke is being made, is fixed by a vertical rod fitted with a cross-head, which is firmly held against the roof by the hydraulic pressure. Instead of being passed along the face of the coal three separate times, as in the case of the pick-machine, for deepening the groove by successive stages, with tools of different form, Messrs. Carrett's coal-cutter penetrates to the depth of 3 or 4 feet, as may be required, by one series of scoops, and thus passes the face only once.

It is probable that these machines may be found variously suitable for seams of different physical character, and although they have hitherto been employed only in a few cases, it must be conceded that they have advanced a long way towards the solution of the question of the feasibility of substituting engine power for hand labour in the most laborious part of the operation of getting coal.

When we proceed to examine the apparatus by which the coal is to be raised to the surface, we find little if any novelty. The continental engineers have followed very closely in the footsteps of our own, and, as they increase the output from individual collieries, are employing models which remind us of the plant of our own larger pits. The newer engines made for this purpose have two cylinders, and act directly on the drum shaft, whilst it is observable that they are almost invariably supplied with that excellent addition, a steam-brake. The works of Creusot exhibit a powerful horizontal engine of this kind. M. Quillacq, the Chatelineau Company, and M. Dorzée, of Boussu, near Mons, have erected vertical winding engines up to 200 horse-power. The Belgian examples have the cylinders mounted on a high pyramidal framing, the piston rods working downwards through the bottom of the cylinder on the drum or rope-roll, which rests on the level of the ground. It may, however, be considered very doubtful whether this new arrangement is so advantageous as our own, where the cylinders are generally on the floor of the building, and the drum is raised into such a position as to enable the rope to pass off in a more horizontal direction to the pulley or sheaves over the shaft.

One colliery, Béthune, interesting as an advanced guard of the northern coal-field towards the Channel, exhibits the head stocks and pulley frame in full size, massive and well put together, with legs of 16 inch square timber at the base, but without any special character. Another pit, that of St. Louis, in the St. Etienne district, has all this apparatus (shown only in model), constructed of wrought iron—a system that has been adopted at the Forster pit of the Seaton Delaval colliery, near Newcastle. The first cost is, of course, much higher than when timber is used, and their economy when used over a series of years has yet to be proved by experience.

The cages in which the wagons or tubs are run up and down the shafts are very similar to our own. Several are shown in full size, which carry from four to six tubs. M. Libotte (Belgium) has made them of steel (as has been done in several of our own northern pits), and thereby greatly diminished their dead weight. Many of the cages are fitted with *parachutes*, or safety catches, to prevent further accident in the event of the breakage of the rope; but in these there is nothing new to remark since the last Universal Exhibition, and, indeed, but little since that of 1855. The Anzin collieries still employ that of M. Fontaine, which has done good service on several occasions. Most of the others depend on the action of an eccentric grip, which is brought into play by a strong spring on the fracture of the rope. It was to be regretted that some of our English inventions for the same purpose, as those of Owen, largely used in Lancashire, and of Calow, which is being fairly tested in Derbyshire and the north, were not exhibited. But it still remains a question, whether, when the winding is very rapid, the employment of this apparatus is, on the whole, productive of advantage.

A large proportion of the continental coal mines are ventilated by the action of mechanical contrivances, but among these nothing of a new construction has been brought forward since the Exhibition of 1862. Three of the best of such ventilators are exhibited in model in the French division, viz., the large flat-vaned fan of M. Guibal, the machine of M. Lemielle, and that of M. Fabry, the two former of which have recently been attached, with good results, to some few of our English collieries, whilst the latter appears still to be confined, after a successful introduction of some years, to Belgium and Northern France.

Among the most suggestive of the objects exhibited from the French coal mines, and of very great value as an element of national economy, are the *agglomerées*, or compressed coal, "patent fuel," and the machinery by which it is formed. The large proportion of "small" or slack which is yielded by most of the French seams, and their frequent admixture with "dirt," or, in other words, with shale, clay, or pyrites, has led our neighbours to pay to the utilization of such material a much larger share of attention than it has received in England. The coal-washing machine of Bérard, and the various modifications which have arisen from it, are almost a necessity in many parts of France, and have been appreciated in several of our own colliery districts, where the small coal thus purified has been found suitable for the manufacture of coke. And it is now above thirty years ago since the first attempts were made to consolidate the small fragments by admixture with a moderate proportion of pitch or tar, and the aid of pressure. The St. Etienne company, which owns the agglomerating work of Givors, exhibits in Paris an excellent model of their apparatus, founded upon the invention of M. Marsais, and in which 120 tons per day are made by a machine which costs about £1600. The proportion of dry pitch (*brai sec*) mixed with the small coal is 5½ per cent., and the great pressure imparted by pistons worked by hydraulic pumps so thoroughly solidifies the masses, that they are satisfactorily water-proof (as might be seen from the blocks that were standing exposed through a great part of the rainy month of April), and admit of distant carriage with far less injury than lump coal. The French navy has experimented largely with this kind of fuel, and it has been proved not only that the destruction by carriage is notably less than with coal, but that, after being stacked abroad for a period of two years, as in the port of Algiers, the loss has been comparatively very trifling.

The Givors machine works with a simple rectilinear forth and back action; but the apparatus more generally employed in France, and in which Messieurs Revollier, Dehaynin, Evrard, and Mazeline have severally worked out improvements, have the compressing cylinders arranged in the radii of a circle, and the pistons packing and forcing the coal from the interior out to the circumference. The colliery company of La Chazotte (France, 8) has exhibited a charming working model of the whole of the machinery required; the Ocean Company (France, 5) another machine; and M. Dehaynin contributes drawings of the apparatus with which, employing 500 people, he turned out last year as much as 175,000 tons of these *briquettes*, suitable for railway or for marine purposes.

It must not be supposed that a similar manufacture is unknown in this country; but when we remember the poor stuff occasionally seen under the name of patent fuel, sometimes crumbly, sometimes too readily melting together, we are satisfied, that although some of our firms may prepare a better article, much more attention ought to be generally paid to the subject. The price of round or lump coal is likely to be steadily rising, whilst the waste of millions of tons of small or "dirty" coal in our mines is a national sin, and both colliery proprietors and landowners often suffer from the faulty or broken condition of certain seams which, on account of the heavy proportion of slack, cannot be worked at a profit.

We may, I trust, indulge a hope that when it is seen what the French are successfully doing with materials which are generally inferior to our own, a stimulus may be given to inquiry into the matter, and that before long we may see in most of our groups of collieries the adoption of such methods of utilizing small coal as shall redeem us from the charge of careless extravagance, too justly brought against us as a nation.

LOCOMOTION IN THE ATMOSPHERE.

BY A MEMBER OF THE AERONAUTICAL SOCIETY OF GREAT BRITAIN.

A QUESTION now and then thrusts itself upon the mind, Is it possible that we shall ever be able to master that wide expanse around us, the air? Shall we ever be able to take our seats in a structure of some kind, and travel with ease and comfort whithersoever we will? In short, shall we ever navigate the atmosphere with as much freedom as we go over land or on water?

One cannot help looking at such an idea doubtfully, even distrust-

fully, and until it is actually proved to be an established fact we can but discuss its probability.

It is of no use telling a practical man how according to theory a thing should be done; rather show him how it has been done, or how from actual experiment you find it must be done. Though this question has disturbed the engineering world but slightly as yet, a successful flying machine is as sure to cause a revolution in our profession as perpetual motion would if that were possible. To fly by mechanical appliances is certainly desirable, if found to be safe; but this is not all, to be extensively adopted it must be of great commercial value. It must not cost too much; it must be economical, perform long journeys without stoppage, must be steered at will and pleasure, no matter whence the wind; it must carry heavy loads, take goods cheaper than at present conveyed on land or water, or it must perform its journey more rapidly and safely. If such a machine be ever constructed, passengers would only travel by it when it transported them more cheaply, or more rapidly, or more comfortably than at present. The means for ascending and descending must be always at hand. Above all, the inhabitants of mother earth will never patronize any aerial travelling machine unless it be free from danger and inconvenience. One will readily see that all these conditions, and a great many more, will have to be fulfilled before aerial locomotion can be pronounced to be anything like a success.

Let us examine the laws by which flying is made an accomplished fact, as seen in nature; these laws are pretty well expounded, but not generally understood. Space forbids an elaborate definition of them in these pages, so we will cursorily glance at those which are least understood. What are the mechanical appliances of flight? The first thing which strikes us in contemplating the subject is the bird, which, though materially heavier, glides so gracefully through every current of the atmosphere, seemingly without an effort, regardless of the direction of the wind. The laws which must be attended to in constructing any flying machine are those which govern the flight of birds, insects, &c. They are, first, The body must be *heavier than air*. Second, That the body, being heavier, must have *power to counteract gravitation*. The third law which presents itself, whether in the screw or in the wing, is, *Leverage on the wind*. But the whole may be expressed in one sentence, viz., *Flight is obtained by atmospheric action and reaction*. The whole theory is comprised in these laws, which are, moreover, incontrovertible and fixed. It remains for practice to prove it otherwise. The screw is pointed out to us as *the* mechanical power most likely to solve the problem; but air is not water, and all attempts hitherto have shown that what is apparent negative slip in the one, is negative slip in the other. Each fresh trial justifies this assertion. For instance, what prevented the American machine (made a few years ago) from rising, but a total slip? It is from the lever, not from the screw, that we hope to see mechanical flight yet accomplished.

It is found that hollow bones, air cavities, feathers, tracheal systems, or gas, are by no means necessary for flight. We observe none of these in the bat, bee, butterfly, beetle, &c., which are expert fliers. Flying animals having large bodies and small wings require to use a greater number of strokes than those animals having large wings, because the small wings, acting as short levers, require to move suddenly and rapidly so as to compress the air sufficiently beneath them in a given time; with large wings there is less exertion necessary in the same time, because of the more extended surfaces acting as levers on the air. Those cases cited above may be very true, and yet be lighter than air; but the first law asserts "the body *must be heavier* than air." It would seem to many that a body made of any of the metals would be directly in opposition to the end we have in view. It seems impossible that metals, except when discharged from a gun, could be made to rise, so that a flying ship seems preposterous. But why not a ship, as much as a kite or a bird? Is either of these not heavier than air?

The atmosphere is a very elastic and yielding fluid, exerting an equal pressure in every direction; and though invisible it resists compression, no matter how employed. It possesses impenetrability, weight, compactness, and elasticity; it is a ponderable substance; it cannot be set in motion without the application of force, and cannot be retarded or resisted unless by an opposing force. Its inertia is exactly in proportion to its weight; it obeys the laws of momentum like all other compact and ponderable bodies. Its momentum exerted on an opposing force is found, as is the case with solids, by multiplying the weight by the velocity. Air, from possessing resistance and impenetrability, will not allow the entrance of another body into the space it occupies; this is observable in the diving bell, where the water cannot displace the air, merely compressing it; and it is well known that after removing a pressure, no matter how great it may have been, it is found to have resumed the same density which it had previous to its compression. This very density, impenetrability, compactness, weight, resistance, pressure, and ponderability are the only causes of a body being sustained in the air; elasticity and resistance are the agents to the bodies in aerial propulsion. Now, if the air opposes the passage of a body through it, and if its density and ponderability be great enough to resist a disturbing force, it must surely by its resistance, reaction, and pressure, be also strong enough to raise that opposing force or body. It is thus with the kite which is held at right angles to a moving current. The boy runs with or pulls the string; here one force is opposed to another in a greater degree than before; the air resists this sudden application of the contrary power; its ponderability and impenetrability will not permit the broad surface of the kite to move broadsides first at the speed the boy runs, and therefore the kite, which must move because of the force applied, is thrust *upward* from the *angle* it assumes, and forward as well. Here is weight in a body opposed to and sustained in that fluid, by the *action* of the boy and the *reaction* of the air. The bird in its flight is acted upon by the same laws. The difference between the bird and the kite is, that the kite is sustained from the earth, has a broad, flat surface, a slight edge resistance, and it contains no power within itself; the bird, on the other hand, severs all connection with the earth the moment it rises, presents a large edge surface, and has to cause a reaction by a power *within itself* in opposition to the action of the law of gravitation. We cannot for a moment dispute the fact that a bird is heavier than air, or that the resistance of the atmosphere being great enough to oppose the passage of that body through it, and dense enough to retard its fall, will also, under certain conditions, be capable of sustaining that body. It is also obvious that if air requires force to set it in motion, being a ponderable body, and if it is unyielding to sudden pressure, being a dense impenetrable substance, then a blow on it from a flat surface must necessarily receive a certain amount of reaction, produced by the elasticity of air, which would tend to throw that flat surface back but for the force or power greater than the reaction which is still applied to that surface. Thus it is precisely with the bird, which, to overcome the atmospheric resistance (the lesser power), has through its wings to employ the greater, viz., *force*. The balloon, from not having a power within itself, is uncontrollable when its large exposed surface is acted on by a current of wind; it is so much lighter than air that the law of gravitation does not sensibly affect it, until its weight be increased by the loss of gas; but even then, in order to overcome atmospheric resistance, it must be of small bulk in proportion to weight and power; for it is only by the greater weight and power that its efforts can be effectual, viz., its power to advance must be greater than the square of the velocity of its surface exposed in square feet. Not even for an instant of time can a body which is to fly be lighter than air, nor is such ever the case. We may conclude, then, that aerial locomotion can only be accomplished by bodies heavier (in every way) than air, and we find that the greater the weight of an animal the quicker and easier is its flight, if able to fly at all. Instances of this may be found in the swallow, which is heavy in comparison with its size of wing; the same may be said of the albatross, the eagle, vulture, heron, and others, which fly so rapidly, because of their great *weight*, *power*, and *leverage* in overcoming the force of gravitation, and attaining momentum.

But how is that power employed, is the next question. The answer is, by turning it to such account as to strike the air below an extended surface, whether it be a screw or a wing, with such a velocity that it will produce a corresponding reaction, or counter-pressure, against that surface, and so tend to raise it. In conjunction with the expending force to rise, it must also expend force to act on an incline to its direction of flight, that it may receive the forward impulse. It must be borne in mind that the action of the wing is similar to the action of the screw, with this difference, that it does not revolve. The wing is not a fair up and down movement; were such the case the bird would find itself, after a few hundred strokes, in the same position as when it first commenced flapping.

Flying animals may be divided into three classes—1st. Those having light bodies devoid of great strength, with large wings to compensate for speed; the butterfly exemplifies this class: 2nd. Heavy bodies

with small light wings, possessing great muscular power necessary to the rapidity of the strokes of their wings; the bee, house fly, sparrow, and partridge belong to this class: 3rd. Heavy bodies with large and heavy wings, whose flight is easy and rapid, because of the great leverage and power they possess. The eagle, albatross, and sea-gull are found in this class. In the first class there is debility, extended surface, buoyancy, and slow progress. In the second class, small surfaces, great power, weight, and medium progress are found. In the third class there is weight, extended surfaces, and power, insuring great velocity. All these classes, possessing, as they do, power absolutely, and weight, carry on their flight under the action of the following laws: —1st. A compression of air by a surface nearly vertical to the line of flight; 2nd. The exertion of power contrary to the force of gravity; 3rd. The body to receive its propulsion from every direction but one, namely, that in which it proceeds; 4th. The greatest available surface to be parallel with the direction of flight; 5th. The smallest presentable surface perpendicular to the direction of flight; 6th. That fall never commences; 7th. That the extended surfaces move as *levers* to the body; 8th. The suspended body to receive sustenance and propulsion from every movement.

In speaking of the compression of unconfined air, we must calculate by the number of pounds per square foot; this is determined by the velocity with which a body travels through the air, or, which is the same, the velocity with which the air strikes that body. If v represent the velocity of the wind in feet per second, then f, the force of the wind on every square foot, would be $\frac{v^2}{440}$, that is, $f = \frac{v^2}{440}$. By using this rule we shall obtain nearly accurate results. Or, again, $f = \cdot 002288\ v^2\ s \sin^2 \beta$, where $f =$ the force in pounds avoirdupois, $v =$ the velocity of the wind in feet per second, $s =$ the surface struck in square feet, and β the angle of incidence. An easier formula to work with is $f = \frac{v^2\ s \sin^2 \beta}{440}$. Borda found by experiment that the force of wind was very nearly as the square of the velocity. This compression of air must, of course, be very great, or else the reaction tending to lift the body could not be obtained. This compressed air must not only lift the body, but the corresponding reaction must sustain it. This can only be the case when the pressure is between the body and its direction of fall. To support a pound dead weight, a pressure of one pound, or more, according to loss from escape of air, must be laid on the air underneath it; by doing this it exerts its power contrary to the force of gravity, and this exertion must be unceasingly employed; to do this, the wing of a bird is so made as to receive its propulsion from every direction, which it obtains from its peculiar construction and varied position during flight. It may be observed that the feathers in a bird's wing are all laid backwards—that is, they run from the rigid to the flexible part; the wing is slightly convex on the outside, and concave in the inside, the concavity being confined to the hard, rigid part, receding from the base to the tip. This rigidity of a portion of the wing is not confined to birds and bats, but the curve only on the wing is. The rigidity extends to all flying animals. In striking the wing downwards, the air is gathered up under it, its greatest effect on the moving surface being when the wing arrives at a position horizontal to that of the body. On account of the front edge being concave and immovable, the compressed air cannot move forward, nor out to the edge, but finds its way towards the base (on account of the rapid descent at the extremity), and to the flexible part because of its yielding under the pressure applied; the reaction of the air immediately sets in on the descent of that surface, and in so doing presses the rigid part forward, and the after part being raised, it is also thrown forward. The wing, when rising, moves similarly as in descending, but to compensate for the front edge being turned *down*, it rises at an angle (depending upon the speed at which the animal is flying, or on the direction of the air current). By receiving the pressure on the surface in that position, it is thrust bodily forward, the air again pressing on the flexible part, but this time downwards. It is a mistake to suppose that the feathers open in the upstroke to allow the air to pass through, as those feathers overlap each other as well as underlap—that is, one-half of each feather from the stem lies under and over its right and left hand neighbour. The principal cause of their being separate is to allow the wing to be opened or closed at will. The upstroke has the effect of neutralizing the rebound of the downstroke, and secures to the body a uniformity of motion. The only parts which present anything like decided resistance to progress is the friction of the front edge of the wing and the surface of the body. The law of gravitation would seem to come into force immediately on the rising of the wing; but if this were the case, why, then, the upstroke, besides neutralizing the upward tendency of the body, would cause it to fall; but this it is not permitted to do, as, from the rapidity with which one stroke follows another, the body does not receive time to descend, and fall never commences. Another reason is, that three forces are acting together on the body—1st. The downstroke throwing the body up; 2nd. The upstroke throwing the body down; and 3rd. The pressure on the wing in both cases throwing the body forward; seeing the wings are fixtures, and do not move without the body, and the two forces being equal to one another, as the rate of motion is the same, the body acted upon cannot follow both, but yields to the third, which gives it an intermediate direction. All these movements in flight could not take place, did the wing not act as a *lever*. Bearing on this point, a very interesting paper was read and illustrated before the Glasgow Association of Assistant Engineers in March last, by a member (Mr. Kauffman) of the Aeronautical Society of Great Britain, whose labours have been devoted to the perfecting of a machine he has recently patented. The following extract is from his paper:— "To sustain itself the bird has to press its entire width of wing on the air below it, which, in the rapidity of its action, serves as a cushion to the wing, and the wing as a lever to the body. . . . The wing of a bird, to obtain a continued flight, has no less than four duties to perform, two in the upstroke and two in the downstroke. . . . In the first duty, that of giving the upward motion, the wing in descending must meet with an obstacle in the shape of atmospheric resistance, and at the same time serve as a lever to the body. The wing, considered as a lever, must have a rest which is supplied by the reaction of the wind." . . . "Supposing that part which joins the body to be a fulcrum, the question then will be, How much power must be applied to each (square) foot of wing to raise the body? (By power here is to be understood the pressure in lbs. of the atmosphere, which the speed of the wings would create per square foot, which pressure increases in direct ratio to the length and width of lever.) Supposing the distance between the fulcrum and the weight to be one-half the diameter of the body, the answer is found by multiplying the weight by that distance, and dividing by the remaining length of the lever, which is the wing, plus its weight. The distance between the fulcrum and the weight cannot be more than half the diameter of the body, because at that point it meets the opposite lever." This must be taken as a supposition, as facts have not yet established such to be the case. He proceeds—"In the calculation it is necessary to take the whole weight depending on each wing separately, as one wing cannot raise the body independent of the other, and each must have the power of balancing that weight against the other. Thus the one must carry the body, so to speak, irrespective of its neighbour."

The gentleman whose paper we have quoted from in illustration of his subject, proceeded to calculate the power put forth by a fly. "One particular fly weighed ·45 grains, the length from tip to tip of wings $= \frac{3}{4}$ inch fully; area of each wing $= \frac{1}{25}$ square inch; distance between weight and fulcrum $= \frac{1}{16}$ inch; rise and fall of each wing, $\frac{1}{4}$ inch; pressure at their extremities ·09 grains; number of strokes per second to obtain this pressure $= 212$:" this pressure being distributed over the whole surface, the wings will have to perform a few strokes more to obtain the maximum resistance; "actual work performed $=$ 4·5 feet travelled through per second $= 19{\cdot}08$ grains, or about ·044 lbs., per square foot; distance the fly travels per hour if travelling without abatement $= 3$ miles." The duke of Argyle, Mr. F. H. Wenham, C.E., and many other members of the Aeronautical Society of Great Britain, have devoted much of their time to this subject, and future reference will be made to them. But to return. The bird does not require to be raised much per stroke; it is more essential that it should be sustained. The long wing of a bird is but a long lever through which, by the aid of a fulcrum and a short end, the motion is transmitted. A great power must be put forth at the shorter end to obtain the results, which is done to much advantage. The economy of long wings may be observed in birds soaring high up in the air, where they receive the force of a moving current, constantly on their wings, which are set at an angle; the pressure against the wing being the same as if it were moving itself. Short wings are incapable of utilizing the current in this manner, as they must always have a

greater force on the shorter lever; but to soar, the body must not, cannot, be stationary, therefore a previously-acquired momentum is essential for it.

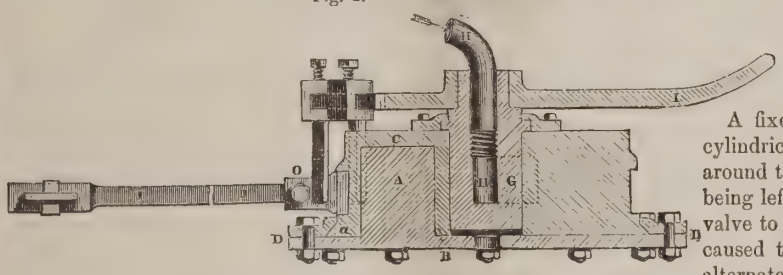
There is not a movement or action of the bird when flying, but produces a certain reaction, either to raise, retard, support, or precipitate the body to the earth. Its independence of the direction of the wind is that which baffles all attempts made hitherto to steer the balloon or any other body of the kind. Every movement, whether in the wing or body, is mechanically arranged to give it either an upward or a horizontal flight. Mr. F. H. Wenham, a councillor of the Aeronautical Society, has done much in his zealous labours to elucidate the laws controlling bodies exposed to moving currents in the atmosphere. Of late a good many attempts have been made to fly by artificial structures.—M.

(*To be continued.*)

THE SUBSTITUTION OF MACHINE FOR HAND LABOUR IN EXCAVATING AND MINING.

In the pages of this Journal we have from time to time brought under the notice of our readers the marked application of invention that has been employed of late years in developing machine in place of human labour for innumerable operations in mining, quarrying, land, river, and harbour engineering. The apparatus has, of course, displayed several different forms and combinations, each depending chiefly upon the specialties of any and almost every individual case. In all probability the original mechanical excavator was the dredger in its simplest form, used both here, in France, and in America first of all, for scraping from the channels of rivers accumulated deposits of the solid matter of sewage—such as human and animal excreta, and other waste or refuse always congregating from any and every dwelling of human beings, but more especially in localities where manufactures are carried on—that have settled on its bed in combination with the eroded matter of the soil and river banks brought down by floods and the ever lowering, cutting, and disintegrating activities of the currents of running water; as well as no small amount of deposit accumulated through the river constituting a receptacle for large quantities of the loose matter drifted into it by the wind from off the surface of the surrounding country.

Fig. 1.



The dredger, when applied only to such cases, was generally but a small and often portable apparatus, still as progress in mechanical applications advanced with the increasing necessities of mankind, the original apparatus was enlarged, strengthened, and altogether so much improved, that now we find it not merely used as hitherto, a cleansing instrument, but as the very essential in deepening and widening the courses of rivers, rendering as navigable harbours what a few years ago were mere fordable rivulets, witness the Clyde, Tyne, &c. Then, again, we have the dredger in other forms actually supplanting the navvy in land operations; for this, we believe, the whole credit is due to one or two French engineers. Couvreux's *Excavateur* has been described in several of its various modifications in these pages throughout the two preceding volumes of the present series;* but apparatus constructed as that is, we must remember, could only be used in sandy soils, such as that through which the Suez Canal is to pass, or in soils at least free from boulders, erratic or ice-born blocks, and, *hoc genus omne*, of geologic obstructions. Again, we have the canal dredgers of M. Perris, which are employed on the Canal du Midi.†

* Vide *Practical Mechanic's Journal*, vol. i, Third Series, pp. 174-176; and vol. ii., Third Series, pp. 297, 298.

† Vide *Practical Mechanic's Journal*, vol. ii., Third Series, pp. 275, 276.

Sea-going dredgers appear now to be the fashion, which for the special cases they are intended unquestionably possess great advantages, to the whole of which we have in these pages so fully alluded that we need not re-enter upon them now.* This last class of engineering apparatus has, we believe, hitherto been manufactured in the Clyde alone; and that almost, and, if we err not, exclusively by one firm, who, a week since the time we write, completed a most powerful example of this class.

That the dredger will yet be used for projecting harbours landwards in places where now the soil is productive of the labour of the agriculturist is certain; in fact, this kind of excavating plant has now become so perfect, that no engineer who is awake to its adaptabilities would hesitate to assert that, by its means, many of our large inland towns could have added to its features a harbour, not communicating to the outlet, whether sea or river, by a mere canal for barges, but that an actual river hollow could be easily cut; and there can be little doubt but that there are cases where it will yet pay to do this, so that the cost of loading into and out of the clumsy canal craft, as well as the more modern railway wagon, may be avoided before the material reaches the ship of transport, thus enabling ships to receive and unload at the very place of the cargo's destination.

We need not here attempt a further review of dredging machinery, but proceed to a certain other direction in which hand has been substituted by machine labour—namely, in mining and quarrying; neither need we occupy time just now in reviewing this radius of inventive activity, as a careful look through previous volumes of the *Practical Mechanic's Journal* will disclose what has been done.

It remains, however, for us to speak of the last form which the "mechanical miner" has received at the hands of Mr. James Hunter, of the Coltness Ironworks; it, in fact, effects the actual functions of the pick, as this is swung by the miner's arm. Now the actual idea of a "mechanical pick" is not new, as may be seen from a previous notice of Munro's steam hammer,† which has, since the date of publication, been successfully used in some coal workings near Glasgow. The present apparatus is, however, to a very large extent a complete inversion of the former, in so far that what are moving parts in one arrangement are many of them fixtures on the other.

The apparatus at Coltness will be fully understood from the following description and the woodcuts adjoining:—

A fixed piston is employed, which fits into the annular space of a cylindrical segment or cylinder, the segment or cylinder being closed around the sides of the piston; sufficient freedom for motion, however, being left, that when steam or compressed air is admitted from a central valve to one on the other side of the piston, the cylinder or segment is caused to revolve or vibrate upon the fixed piston, as the steam is alternately admitted on its opposite sides from the two ports in the central valve, through one of which the steam from the full side of the cylinder or segment is exhausted, whilst fresh steam is being admitted through the other port to the other side of the segment, the ports being opened and closed by the rotation of the segment over the central valve.

Fig. 1 is a vertical section of the apparatus; fig. 2 is a horizontal section looking towards the under side of fig. 1; fig. 3 a plan; and

Fig. 2.

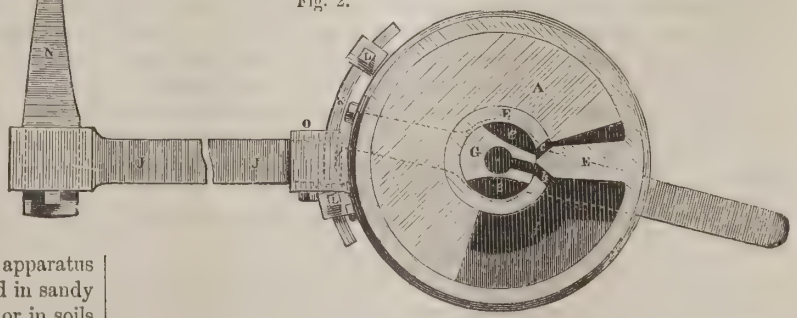


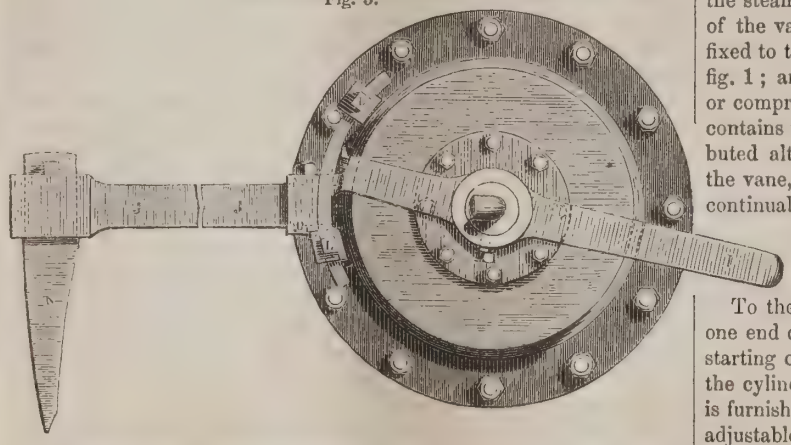
fig. 4 is a side elevation; fig. 5 being a detached elevation of one of the tools or picks for cutting into the face of the rock, which, when in

* For a full description of sea-going dredgers, vide *Practical Mechanic's Journal*, vol. i., Third Series, paper on "Clyde Dredging," &c., with special reference to the sea-going dredger of Messrs. Simons & Co., Renfrew, pp. 292–296.

† Vide *Practical Mechanic's Journal*, vol. i., Third Series, page 317. January, 1866.

use, is fitted into the end of the vibrating lever. When in use in a mine, quarry, or elsewhere, the excavating apparatus is mounted on a truck or other travelling carriage, which is propelled along a line of rails.

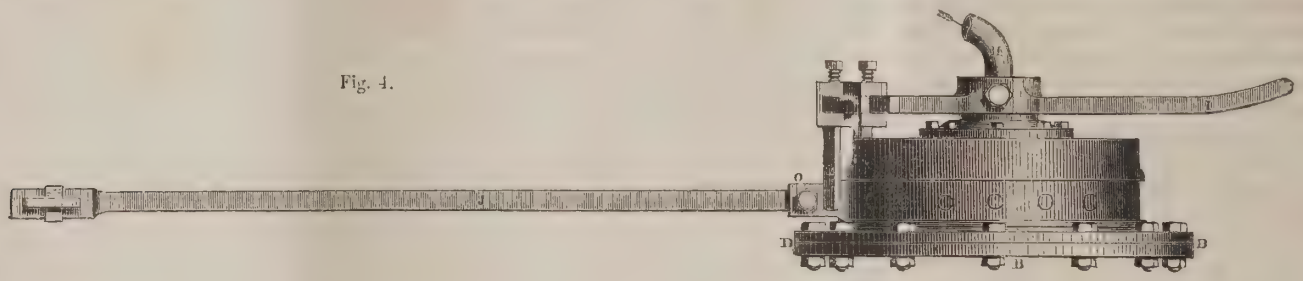
Fig. 3.



The apparatus consists of the piston, A, which is cast in one piece with the bottom plate, B; the segmental form of the piston, A, is seen at fig. 2. Outside and enveloping the fixed piston, A, is the cylinder, C; and it is held down in place by the joint ring, D, which is bevelled off on the inner side, as shown at fig. 2; thereby, when bolted to the plate, B, forming an angular recess, into which the corresponding angular projection, a, round the bottom of the cylinder, C, fits; the bevelled joint being formed so that the cylinder, C, is free to turn therein when the steam or compressed air is let into the cylinder on one side or other of the vane, E. The central piece, F, containing the ports, b and c, is fixed to the upper side of the cylinder, C, as shown in transverse section, fig. 1; and within it is situated the central piece, G, to which the steam or compressed-air pipe, H, is connected as shown. This central piece contains the port, d, by which the steam or compressed air is distributed alternately to the ports b and c, thence to the alternate sides of the vane, E, thus causing the vane, and with it the cylinder, C, to be continually vibrated in alternate directions on the fixed piston, A. The sectional form of this central piece, G, is shown at fig. 2; on either side, the cavities, e and e', are left through which the used steam or compressed air exhausts.

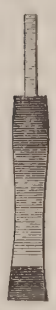
To the upper end of the central piece, G, there is fixed the lever, I, one end of which is formed into a handle for the attendant to hold in starting or stopping the excavator, or adjusting the length of motion of the cylinder, C, and cutting lever, J. The opposite end of the lever, I, is furnished with a quadrant, K; the quadrant being provided with two adjustable stops or tappets, L, which extend far enough downwards, as shown at figs. 1 and 4, to be struck by the lever, J, as the latter approaches toward either extremity of its movement; so that by placing the stops or tappets, L, either closer together or farther apart, the extent of angular motion of the apparatus may be regulated at the will

Fig. 4.



of the attendant. On referring to fig. 2, the steam or compressed air is passing through the port, b, into the space, f, and has carried the apparatus to very nearly one end of its stroke; it has, however, a short distance further to move through before the stroke is complete. At the position thus shown, the lever, J, has come into contact with the stop or tappet, L; and the lever, J, in moving through the remainder of its stroke, carries with it the lever, I, through a distance sufficient to turn round the central piece, G, to an extent sufficient to bring the port, e, in the central piece over the port, c, leading into the other side of the vane, E; whilst at the same instant the port, b, is opened to the exhaust cavity, so that the steam or compressed air just used for producing the backward stroke escapes, whilst fresh steam or compressed air is admitted in the opposite side to produce the reverse stroke of the apparatus. These alternate movements being continued, the continuous action of the apparatus is maintained. The lever, J, carrying the excavating tool, N, is fitted into the socket, O, bolted to the outside of the cylinder; and a series of holes is provided all around the cylinder, so that the cutting lever, J, may be attached at any part thereof, and, if required, more than one cutting lever may be so appplied.

Fig. 5.



In place of using a complete cylinder, C, a cylindric segment may be employed; in which case the fixed piston, A, is divided into two fixed pistons forming abutments, from which the steam actuates the moving parts of the apparatus.

The shape of the cutting tool or pick will, of course, principally depend upon the nature of the material to be excavated.—V. D.

ON THE FLOW THROUGH APERTURES OF SOLID BODIES.

(*Continued from page* 8, *Vol. III., Third Series.*)

Distances of the Couches in the Jet.

As a corollary to the preceding question, it is easy to determine the distance. x, from the extremity of the outer portion of the jet to the extremity of the inner part of the jet, formed by a couche which was originally at a distance, A, from the upper face.

The original volume of that part of the central cylinder, situated above that couche, was measured by $\pi R_1^2 (H - A)$, and that volume becomes transformed into that of a solid of revolution, whose meridian we come to determine; the distance, α, will then be such that the lower part of the new solid, comprised between the bottom of the jet and the plane situated at a distance, α, should be equal to that which we have written above; we have then

$$\int_{y=o}^{y=a} \pi x^2 \, dy = \pi R_1^2 (H - A).$$

We shall deduce from the equation of transformation (6) the value of x in terms of y, and substitute that value of x in the preceding equation, and also determine the value of the limit, α, which shall satisfy that equality in suppressing the factor, π, which is common to both members.

Equation (6) gives

$$\left(\frac{x}{R_1}\right)^{\frac{2R_1^2}{R^2 - R_1^2}} = \frac{R_1^2 y - R^2 H}{-R^2 H}$$

or

$$\alpha = R_1 \left(\frac{R^2 H - R_1^2 y}{R^2 H}\right)^{\frac{R^2 - R_1^2}{2R_1^2}},$$

and we therefore find—

$$\int r^2 \, dy = -R_1^2 H \left(\frac{R^2 H - R_1^2 y}{R^2 H}\right)^{\frac{R^2}{R_1^2}} + C.$$

In successively making $y = \alpha$, and $y = o$, and in subtracting the second value from the first, it comes finally—

$$R_1^2 H - R_1^2 H \left(1 - \frac{R_1^2 a}{R^2 H}\right)^{\frac{R^2}{R_1^2}} = R_1^2 (H - A),$$

from which we deduce—

$$1 - \frac{R_1^2 a}{R^2 H} = \left(\frac{A}{H}\right)^{\frac{R_1^2}{R^2}},$$

and

$$a = \frac{R^2 H}{R_1^2}\left[1 - \left(\frac{A}{H}\right)^{\frac{R_1^2}{R^2}}\right] \quad . \quad . \quad . \quad (8.)$$

To apply this formula to the case of the cylindrical blocks, composed of N equal plates, we shall designate by n the number of plates which constitute the height, A, and we thus have that—

$$\frac{n}{N} = \frac{A}{H},$$

whence by substitution

$$a = \frac{R^2 H}{R_1^2}\left[1 - \left(\frac{n}{N}\right)^{\frac{R_1^2}{R^2}}\right] \quad . \quad . \quad (8\ bis.)$$

It is this expression which has been used in effecting the calculations for all the jets—the distances of the lines of successive joints to the extremity. We have in each case compared the curve having for its abscissæ the different values of n, and for its ordinates the corresponding values of a, to the curve drawn with the same elements measured upon the experimental specimens themselves. It is believed that the accordance between the two curves is perfect in a great number of instances, and we are therefore enabled, in a case of discordance, to seek out the causes which produce it.

Radius of the Lower Face of each Jet.

The value of the radius will be determined by that of x (equation 6) corresponding to the preceding value of $y = \alpha$.

In designating it by x^1, and solving this equation, we find—

$$a = \frac{R^2 H}{R_1^2}\left[1 - \left(\frac{A}{H}\right)^{\frac{R_1^2}{R^2}}\right] = \frac{R^2 H}{R_1^2}\left[1 - \left(\frac{x'}{R_1}\right)^{\frac{2R_1^2}{R^2 - R_1^2}}\right],$$

whence

$$\left(\frac{A}{H}\right)^{\frac{R_1^2}{R^2}} = \left(\frac{x'}{R^1}\right)^{\frac{2R_1^2}{R^2 - R_1^2}} \quad . \quad . \quad . \quad (9).$$

It was formerly remarked that if R_1 was very small with respect to R, and if its value was insignificant enough to be neglected in the index (*dans l'indice de la puissance*), we have simply—

$$x' = R_1\left(\frac{A}{H}\right)^{\frac{1}{2}},$$

or more simply—

$$\frac{x'^2}{R_1^2} = \frac{A}{H} = \frac{n}{N},$$

which corresponds to saying that the section of any jet will measure itself in multiplying the section of the entire jet, with respect of the number of plates comprised in the jet with the total number of the plates.

(*To be continued.*)

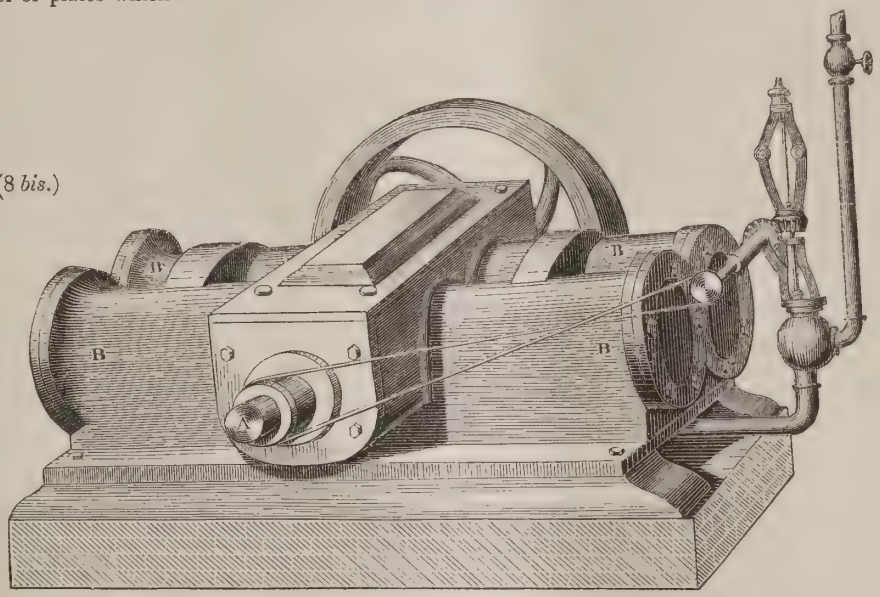
THE "HICKS' ENGINE" AT THE PARIS EXHIBITION.

Amongst some drawings we have received from Paris, is a perspective view of a novel arrangement of steam engine, christened, after the name of its inventor, the "Hicks' Engine." This engine, it appears, has attracted a good deal of attention in the States, and a company has been formed, who occupy works at Newcastle, in the State of Delaware, for its production. We understand that a large number of them are at work in America.

The engraving, which is a perspective view of the horizontal form, strikes the eye accustomed to British types of engines as peculiar, and, no doubt, some will think faulty. Its arrangement is as follows:—

Four single-acting pistons working in the four cylinders marked B, B, B, B, are all connected to cranks on one shaft, A, by connecting rods attached at the inner end of the tubular pistons, each piston taking steam before the next succeeding one has finished its stroke, thereby insuring an uniform and continuous motion, and avoiding the dead points which render ordinary engines so variable in their motions, and difficult to start, if stopped or caught on a centre. This is, in fact, a double cut-off engine, without the friction of a double set of valves with their attachments.

The pistons are provided with ports and passages, which act in combination with ports and passages in the cylinders, to admit and release



the steam, thus combining a slide-valve with the piston in one and the same piece, each piston admitting and exhausting the steam for its neighbour cylinder, as well as cutting off its own supply of steam from the boiler at any desired point. By this means the expansive force of the steam is used, and the exhaust allowed to remain open during the entire return stroke.

These ports and passages are arranged opposite each other in such a manner that a perfect balance to the pressure of the steam is effected, and the ordinary wear and friction of cylinders, pistons, and valves, almost entirely obviated. It will also be observed that the motions of the valve and cut-off are equal in rapidity to the speed of the piston.

The pistons are effectually packed by a simple and convenient method, similar to that used in ordinary engines, and can be tightened at pleasure.

It will be apparent from the engraving that all the working parts are encased in one casting, and in no way exposed to the action of the weather, or to an accumulation of dirt.

The number of parts and wearing surface being so reduced, tend to a decrease of wear and tear, and of the risks and costs of repair. The facility of repairs is considered important, since every part being accessible by the removal of a few bolts, and the whole machine being capable of dissection and reconstruction in a few minutes; and the parts also being interchangeable, any portion can be quickly and cheaply replaced.

The reduction of friction; the diminished length of the steam-ports and clearances; the decrease of the surface exposed; the facility for casing the whole engine; the accuracy of the valve motions and cut-off; the extent to which the expansion of the steam may be carried to advantage—whatever some of these expressions may mean, are stated by the makers to give an unequalled economy in the consumption of steam.

This engine is patented in Great Britain; and those of our readers who may wish to refer more fully to its peculiarities should procure Mr. Hicks' specification, No. 166, A.D. 1865.

General Beauregard, it is stated, is a shareholder in the Hicks' Engine Company.

We were informed by a gentleman who was in Paris throughout the first month of the Exhibition, that the Hicks' engine exhibited was purchased directly its advantages were shown.—V. D.

PARIS EXHIBITION, 1867.

CARDING ENGINE.

(Illustrated by Plates 4 and 5.)

AMONGST the cotton machinery at the Paris Exhibition we noticed an excellent example of carding engine, exhibited by the makers, MM. Schlumberger & Co., of Guebwiller. We are indebted to the *Publication Industriel* of M. Armengaud Ainé for the plate engravings and description of this engine, which we now lay before our readers. Fig. 1, Plate 4, represents an elevation of the driving side of the improved carding engine, provided with a self-acting top stripper invented by Mr. G. Wellman, of Lowell, U.S., A. Fig. 2 is a general plan of the same; fig. 3, an elevation of the delivery end of the machine, with the revolving case removed. Fig. 4, Plate 5, is an elevation of the opposite side of the machine to that seen in fig. 1. Fig. 5 is a longitudinal vertical section, showing the working cylinders and the course of the cotton; and fig. 6 is an elevation of the feeding end of the machine. In the plan and end views the outer covering is removed, in order to show more clearly the internal arrangement. On referring to these different views, it will be seen that the machine consists essentially of two cast-iron frames, A A^1, connected by cross bars, *a*, intended to support the various working parts of the machine. The first of these is the main carding drum, B, which is situate nearly in the centre of the machine. It is inclosed on its under side by a thin plate, b^1, provided with a grid, b^2, which allows the dirt to escape; this grid is shown clearly in fig. 5. The card cylinders, flat tops, and other working parts, are grouped around the drum, B. On referring to fig. 5, there will be seen the "taker-in," *b*, provided with strong card teeth, and receiving the fleece of cotton from the fluted roller, *c*, as it is delivered from the roll, C. The delivery of the fleece is facilitated by the smooth feeding roller, c^1, upon which the fleece roller rests, and which receives a slow rotatory motion. The taker-in gives a preparatory cleaning to the cotton before delivering to the main card drum, B; being driven at a high velocity, it takes the cotton from the fluted roller, C, which revolves slowly, and transfers it to the main drum. This, by rotating in the direction of the arrow, presents the covering or layer of filaments which it contains to the action of the first "worker" or cylinder, C^1, which is stripped by the small cylinder or "clearer," *e*, from which the filaments return to the main drum, but in a different place from whence they were taken off, as the main drum receives a continuous rotatory motion. The filaments thus restored and worked by the action of the first pair of cylinders, are re-worked by a second pair of similar cylinders, C^2 e^1. These various transfers of the filaments from the main drum to the workers and clearers are accomplished by the different inclinations of the card teeth of the cylinders, the direction of their rotation, and the distances between the cylinders. The adjustment of the space between the cylinders is effected by a steel gauge plate of varying thickness. The workers are only just out of contact with the main drum, whilst between the clearers and the main drum there is a space of about 1-25th part of an inch. The speed of the main drum being determined, and the inclination of its card teeth being in the direction of the rotation of the drum, it will be readily understood, that if the circumferential speed of the workers be much lower than that of the main drum, a combing action will be produced upon the fibres between the workers and the drum, which will tend to progressively straighten the filaments. This first carding, whilst picking and straightening the fibres, still leaves them but imperfectly cleaned; therefore a series of fixed "flat-top cards" are disposed behind the workers, between which and the main drum the filaments are compelled to pass, in order to effectually remove all dirt from the cotton, and lay the fibres perfectly straight and parallel on the surface of the main drum. In the Plate ten of these top cards are shown; they are fixed round the drum, B, and retained in place on the standards, A A^1, by pins, *f* (fig. 13), which pass freely through them, and are kept at the proper height by the small regulating screws, f^1. The top cards are provided with teeth of gradually increasing fineness towards the delivery end of the machine, and are so adjusted as to form an acute angle, of which the opening of about 3-16ths of an inch faces the workers, whilst the apex, like all the other workers, approaches very near to the circumference of the drum, and being turned in the direction in which the cotton is delivered, a series of angular spaces is obtained, in which the fibres are carded and deposit their grosser impurities. Behind the last of the top cards there is formed an inclined opening, provided with a small blade, b^3 (fig. 5), which permits the dirt which has escaped the action of the top cards to pass out to the exterior of the machine. The fibres of cotton, on leaving these top cards, are ranged parallel with each other on the surface of the drum; and if the parts have been properly adjusted, the material is completely freed from the knots and foreign bodies which have escaped the action of the scutcher. It is at this point that the doffer card, B^1, by reason of its slower rate of rotation and the direction of its card teeth, receives the fleece of cotton from the main drum, which is in turn detached from its surface by the comb, *p*, to be gathered together and forced, in the form of a sliver, through an oblong opening in a metal plate, *p*, forming a species of funnel mouth, whence it proceeds between the fluted rolls, c^2 c^3, and there receives a slight elongation or drawing, and is finally directed into the revolving can, P, in the interior of which the sliver is symmetrically disposed. At the lower portion of the main carding drum, B, and beneath the taker-in, *b*, are disposed two other cylinders, D and *d*, provided with card teeth; the first one, D, called the stripper, is intended to completely strip or clear the main drum, B, at certain periods of the working of the machine. With this view, the circumferential speed of the cylinder, D, is suddenly accelerated, so as to exceed the velocity of the main drum, and hence the stripping takes place; afterwards the speed decreases, and the stripper becomes, for the time being, a taker-in, that is to say, it returns the cotton to the drum. The cylinder, *d*, which is called the *intermediate* cylinder, by reason of its position between the taker-in and the stripper, receives the cotton from the stripper and transfers it to the drum; its speed of rotation is uniform. The same plate, b^1, which incloses the drum, B, is continued round the stripper and the intermediate cylinder, in order to prevent any escape of the dust or filaments into the work-room. The main drum, B, of cast iron, is fixed by its arms upon a horizontal axis, B^2, which revolves in the bearings, a^1, secured to the standards, A A^1, and carries the fast and loose driving pulleys, M M^1, which receive the driving strap from the shafting in the mill. This shaft, B^2, which is, in fact, the main driving shaft of the entire machine, is furnished for this purpose on the side of the driving pulleys with a pinion, *i* (figs. 1, 2, and 3), which, by the intermediate wheel, D^1, imparts motion to the wheel, i^1, carrying the pinion, *j*; this pinion transmits motion to the doffer card, B^1, through the wheel, J, fixed on its axis. This wheel, J, gears into the intermediate wheel, J^1, which again gears into a pinion, *g*, fast on the spindle, a^2, which transmits motion to the fluted delivering rollers, c^2 c^3, and to the different working parts in connection with the revolving can, P, which is described in detail below.

We may remark that the wheel, i^1, and its pinion, *j*, are free to slide along their fixed stud centre, i^2, so as to be independent of the wheels, D^1 and J; by this means the movement of the doffer card, B^1, feed roller, *c*, and of the fluted rollers in front of and belonging to the revolving can, P, may be arrested without stopping the main drum, B, and the other carding cylinders. In the same way the wheel, J^1, may be disengaged by sliding it along its axis, j^2, from the wheel, J, so as to stop the fluted delivering rollers and the revolving can, whilst the main drum and the other cylinders continue their revolutions.

The driving of the feed mechanism is effected in the following manner:—Upon the shaft of the doffer card, B^1, and on the side opposite to the driving pulleys, there is fitted the spur wheel, E (figs. 2 and 4), situate inside the small pulley, E^1, the sole object of which is to receive a strap for guiding the cards of the cylinder, B^1. The wheel, E, gears with the wheel, E^2, fixed on the small horizontal spindle, E^3, carried by brackets, e^2, secured to the frame, A^1, and provided at its extremity with a bevel pinion, I; this pinion gears with the large wheel, I^1, fixed on an extended portion of the axis of the fluted feed roller, *c*. This roller, as will be seen on referring to fig. 5, revolves in a species of cast-iron trough formed by the feeding table, G^2; it receives at each extremity a certain amount of pressure from two counterweights, G, carried by the two levers, G^1, which, having their working centres fixed to the main frame, transmit the pressure by means of two small rods which bear upon the upper brasses of the fluted roller, *c*. To the opposite extremity of the feed roller spindle is fixed the pinion, g^1 (figs. 1, 2, and 6), which, by the aid of two intermediate wheels, transmits motion to the wheel, g^2, keyed on to the end of the roller, c^1, upon which rests the fleece roller or beam, C. In actuating the worker cards, one of the intermediate wheels, D^1, which serves to transmit the motion from the main drum to the fluted delivering rollers, gears also with another

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CARDING ENGINE WITH WELLMAN'S TOP STRIPPERS.

MESSRS N. SCHLUMBERGER & Co OF GUEBWILLER,
ENGINEERS.

Fig. 4.

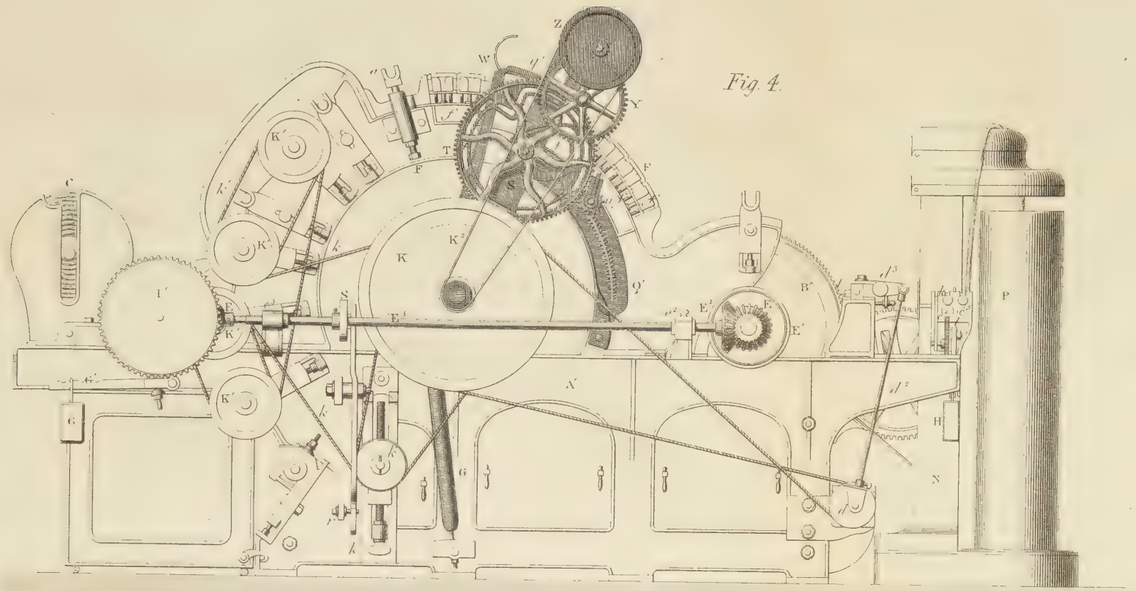

Fig. 6

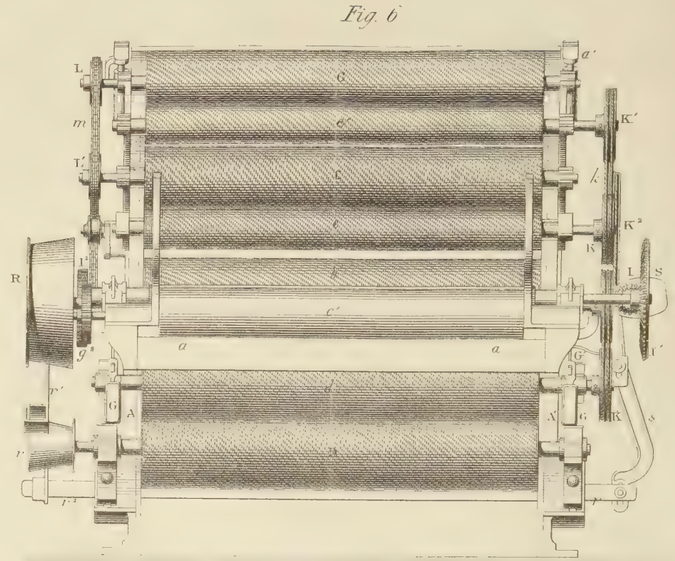

Fig. 5.

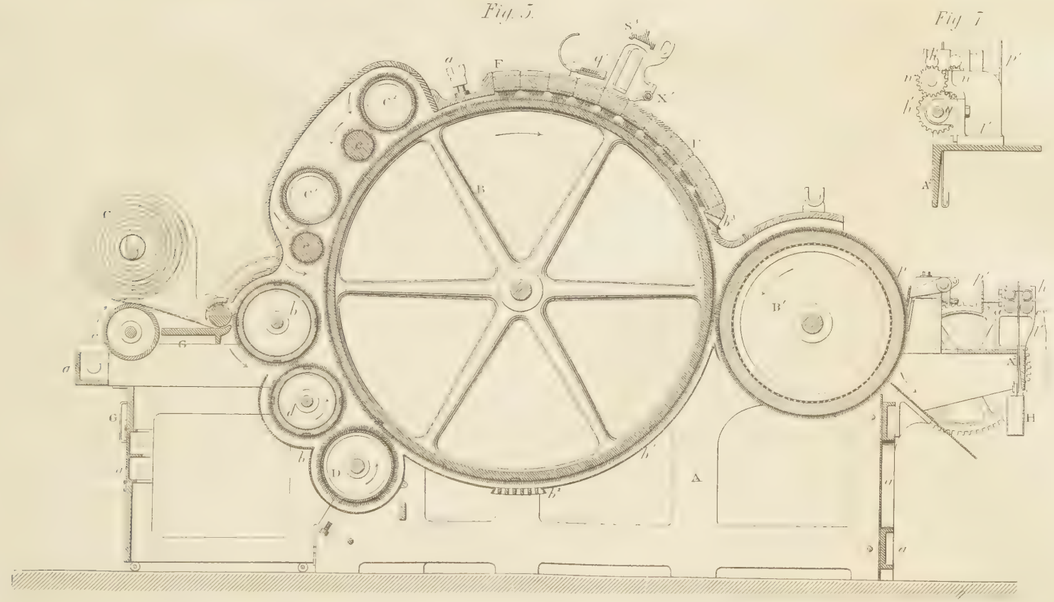

Fig. 7

Fig. 8

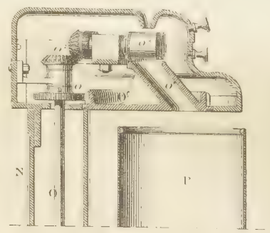

Fig. 10.

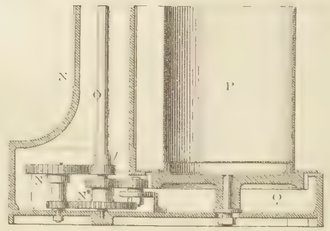

Fig. 9

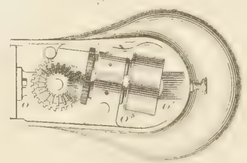

Fig 11.

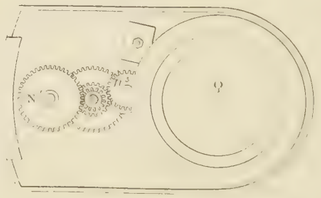

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Fig. 13.

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CARDING ENGINE WITH WELLMAN'S TOP STRIPPERS.

MESSRS N. SCHLUMBERGER & Co OF GUEBWILLER.
ENGINEERS.

Fig. 1.

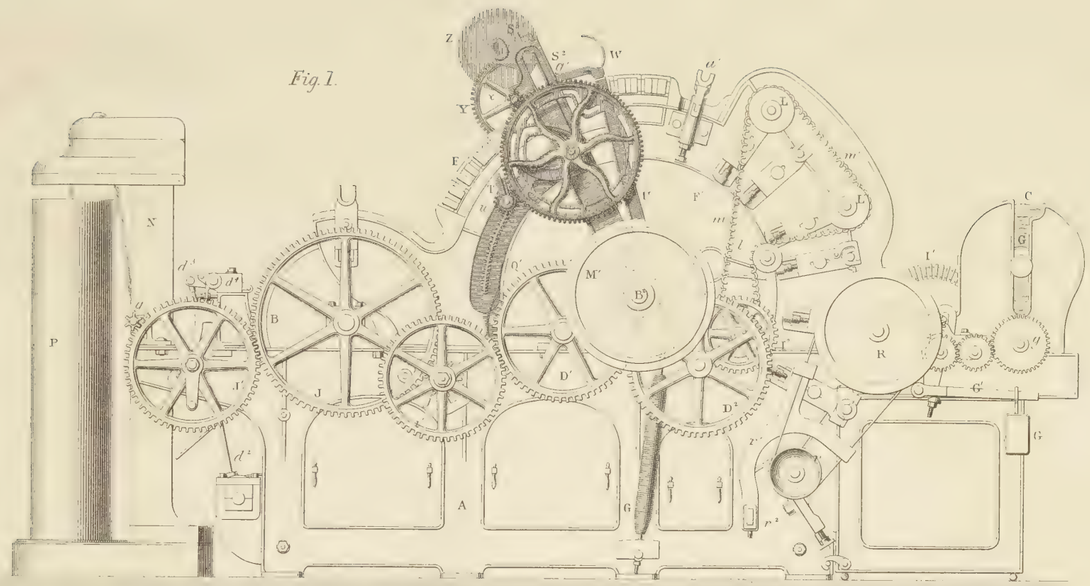

Fig. 2.

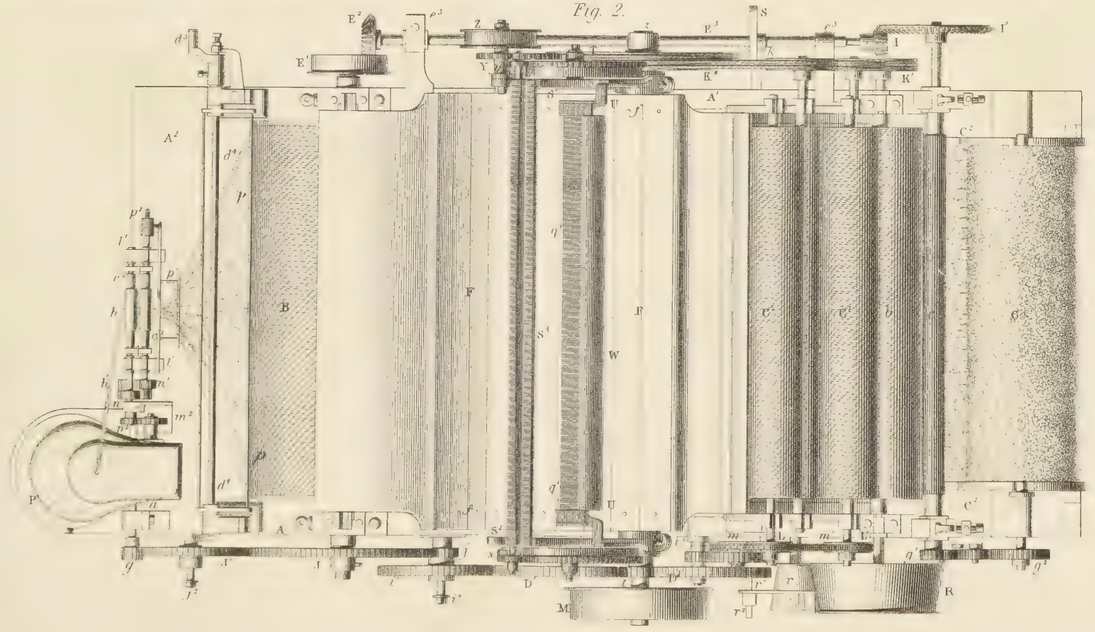

Fig. 3.

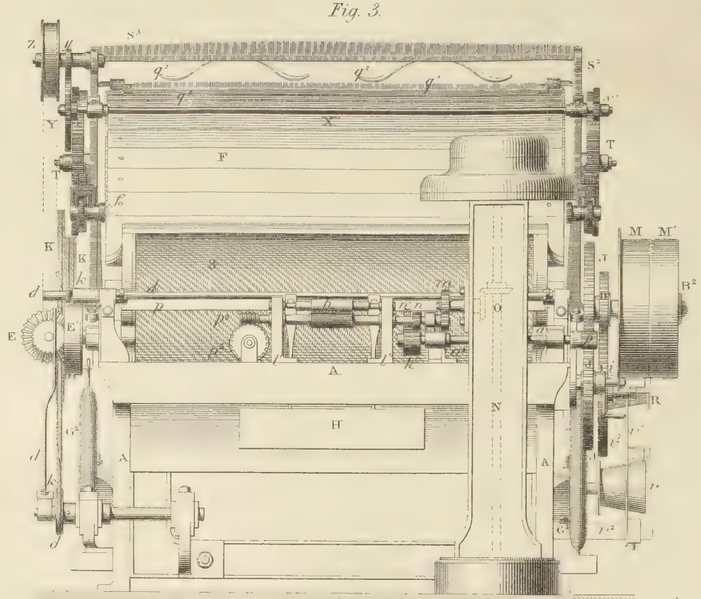

Fig. 12.

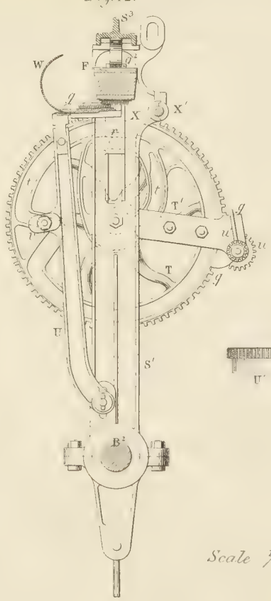

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Fig. 14.

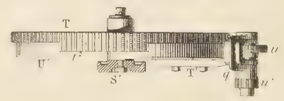

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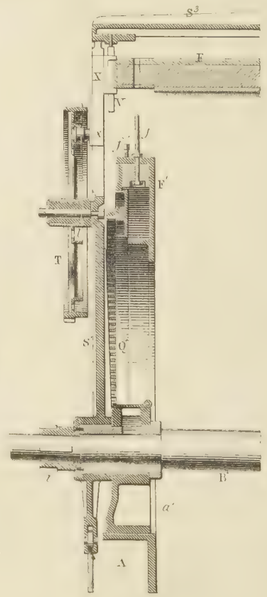
Fig. 13.



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wheel, D², of the same diameter, fixed to the pinion, i^3 (fig. 2), which drives the wheel, I², upon which is fixed the chain wheel, m. This latter imparts motion to the workers, C¹ C², by means of the endless chain, m^1, which simultaneously gears into the wheels, L and L¹, fixed on the prolonged axes of the workers, to which a slow motion is imparted to suit the work to be performed. A small counterweighted pulley, l, serves to maintain a proper tension on the endless chain.

The following is the mode of driving the clearers, taker-in, and intermediate cylinder :—Upon the shaft of the main drum, and on the opposite side to the driving pulleys, there is keyed the large double-grooved pulley, K, over which is passed the endless band, k (figs. 2, 3, and 4), which passes also over the four small pulleys, K1, fixed on the ends of the axes of the clearers, e e^1, taker-in, b, and intermediate cylinder, d. The band, k, passes twice over the pulleys, K¹, in order to obtain better adhesion; for the speed of these pulleys being considerable, and their diameter small, if the band only passed once over them a slip would be liable to be produced, which would materially interfere with the proper working of the machine. In order to maintain the band, k, at the proper tension, a small pulley, k^1 (fig. 4), is mounted on an axis, through which passes an adjusting screw, k^2, capable of being rotated by hand, by which arrangement facility is also afforded for the ready removal of the band when the main drum or any of the other carding cylinders require grinding. With the pulley, K, there is cast another, K², provided with one groove only, its object being, by the aid of the band, k^2, to drive the pulley, d^1, carried on an intermediate axis supported in bearings attached to the lower part of the frame, near the delivery end of the machine. The pulley, d^1 (figs. 3 and 4), carries a crank pin, to which is connected the rod, d^2, which, by the crank, d^3, fixed on the end of the wrought-iron spindle, d^4, serving as the centre of oscillation of the doffer, p, communicates to this latter the rapid vibratory motion which is required to detach the cotton from the card teeth of the doffer card, B¹.

It has been explained that the taker-in, b, received its motion from the shaft of the main drum by the grooved pulleys, K K¹, and band, k. This taker-in drives in its turn the stripper, D, by means of the conical pulley, R, fixed on the extremity of its axis on the same side as the main driving pulleys (figs. 1, 2, and 6), which pulley, by means of a strap, transmits motion to the pulley, r, fixed on the axis of the stripper card. These two conical pulleys, R r, are sufficiently wide to admit of the strap having a certain amount of lateral play, in order to produce the variable speed of rotation required in the stripper card, as above described. For this purpose a curved strap shifter, r^1, embraces the strap, and displaces it at the proper periods of time by the action of the small cam, S (figs. 2, 4, and 6), fixed on the horizontal shaft, E³; which cam acts upon a friction roller in the upper end of the vibrating lever, s, connected at its opposite end by the rod, r^2, which passes across the machine, and is connected at its opposite end with the forked shifter, r^1. The form of the cam, S, imparts to the lever, s, a to-and-fro movement, which is transmitted at the proper intervals by the rod, r^2, to the strap shifter, r^1, so as to cause the strap to slide alternately at every revolution upon the smaller diameters of the pulleys, R and r. When the strap is on the small portion of the pulley, R, it will be on the larger diameter of the pulley, r, and the speed of the stripper will be sufficiently slow to enable it to operate as a deliverer; when the reverse position is assumed the speed of the stripper is accelerated, and the stripping of the drum takes place. The horizontal shaft, E³, which produces the change of speed, and which gives at the same time the feed motion to the card, is mounted in bearings, e^3, in such a manner as to be capable of sliding easily therein, which permits of the disengagement of the wheel, E², from the wheel, E¹, and thus completely arrests the feed motion, either at the moment the stripping is effected or during the time the stripper delivers the cotton to the main drum. To effect this throwing out of gear of the shaft, E³, it is simply requisite to withdraw a pin which retains it in one of its supports, e^3 (figs. 2 and 4), the bearing is moved, and with it the shaft and the wheel, E², which is disengaged from the wheel, E¹, from which it derives its motion. The drum continues to revolve, but the feed is stopped. The fluted front rollers, c^2 c^3, are placed parallel to each other in two small supports, l^1, fixed to the cross bar, A³, which connects the front ends of the standards, A and A¹; they are surmounted by two small pressing rollers, h (figs. 2, 3, 5, and 7), upon which acts the weight, H. The arrangement of these rollers is the same as that of other driving rollers employed in spinning machinery. As before stated, these fluted rollers are driven by the intermediate wheels, J J¹, and the pinion, g, fixed to one of the ends of the shaft, a^2, which carries at its opposite extremity the wheel, h^1, which gears simultaneously with the two pinions, n and n^1, keyed on to the extensions of the spindles of the fluted rollers, c^2 c^3; the pinion, n, has four more teeth than the pinion, n^1, in order to produce a drawing or elongating action on the sliver. The spindle of the fluted roller, c^2, is prolonged on one side of the machine, in order to receive the worm, p^2, which, by means of the small toothed wheel, p^3, forming a crank, imparts to the trumpet mouth or guider, p^1, a to-and-fro movement. At the opposite end this spindle carries the spur pinion, n^2, which gears with the pinion, m^2, mounted on a small intermediate spindle fitted in a collar on the rectangular cast-iron column, N, of the revolving can. The sliver is deposited in the revolving can in a series of superposed rings laid eccentrically upon one another, this arrangement having been found the best for facilitating the subsequent withdrawal of the sliver in the succeeding operations.

Upon the extended spindle of the fluted roller, c^2, and in the interior of the column, N, which supports the cap of the revolving can, there is fixed a bevel pinion, shown in dotted lines in fig. 3, which gives motion to the vertical shaft, O, inclosed in the interior of the column. At the upper part, as shown by the details, figs. 8 to 11, the shaft, O, carries a small collar cast in one with two toothed wheels; the one, a spur wheel, o, drives a plate, O¹, cast in one piece with the inclined conductor, o^1, through which the sliver descends on leaving the small drawing rollers, c^3, actuated by the pair of bevel wheels, o^2. At the lower part this vertical spindle, O (figs. 10 and 11), is provided with the pinion, l^2, which, by means of the two intermediate wheels and pinions, N¹ and N², actuate, through the pinion, n^3, the toothed plate, Q, upon which is placed the tin can, P, which receives the sliver of carded cotton. It thus follows that the sliver, which is directed by the rollers, o^3, into the inclined conduit, o^1, describes a circle of a given diameter, which it developes inside the revolving can, P, which is itself rotated slowly upon its own axis. The cap and the can thus receiving a separate and independent rotatory motion on their respective axes, the sliver is disposed in the interior of the can in the manner above described, namely, in the form of a series of superposed rings distributed round the centre of the can itself, but not concentric therewith; a small empty space being left in the centre along the full depth of the material deposited in the can. When the can is filled, the sliver does not escape, but is pressed down by the cover; this produces a compression of the material, and enables the can to accommodate a larger quantity of the sliver.

As regards the details of construction of the cylinders of carding engines, we may observe that great care and accuracy are required in their manufacture. The cylinders should be perfectly balanced, and revolve in a perfect circle, without any eccentricity. They should be light in proportion to their size, and sufficiently strong to prevent their becoming deformed or losing their perfectly cylindrical shape. They were formerly made of mahogany, but this material was found in time to lose its shape, and the cylinders required to be re-made. The diameter of the drum cannot be altered without causing considerable inconvenience in the adjustment of the various surrounding parts. It has also been difficult to render the drum perfectly rigid, and therefore the practice now is, whilst not increasing the thickness of the drum beyond about half an inch, to form a base or foundation of fine plaster, in which are imbedded a number of wooden laths extending the full width of the drum. These laths are introduced to receive the nails which secure the card clothing. On referring to the section, fig. 5, these laths will be clearly seen in their places. The plaster possesses the advantage of not working loose, and thus the cylinders remain perfectly round; but, on the other hand, it is extremely fragile, and great care is required to prevent accidents. The smaller drum, B¹, is composed of two cast-iron end discs keyed on to the wrought-iron axis. These two discs are connected by a covering of wirework like the large drum, upon which a layer of fine plaster is run, and when dry, this plaster is turned down. The card clothing is secured at its two extremities by means of screws tapped into the end plates. The taker-in, b, and intermediate cylinder, d, are constructed in a similar manner, excepting that the card clothing is secured thereon, as on the large drum, by means of nails driven into four laths of wood imbedded in the plaster. The stripper card, D, is composed of five discs keyed at equal distances on the shaft, and covered with sheet metal, upon which the card clothing is secured. The small clearers, e and e^1, being of small diameter, are of cast iron, made hollow. The top cards, F, are entirely

of wood covered with mahogany, the cards being fixed to the underside thereof by nails.

It will thus be seen that the mode of construction of the cylinders of carding engines is a most important feature; and hence the best makers devote considerable care and attention to this part of the machine.

It is highly important that the card teeth on the cylinders of carding engines be maintained, as near as practicable, perfectly regular and even; and this is accomplished by frequent grinding of the surface. In grinding the main drum, it is allowed to remain in its place in the machine, and a cast-iron cylinder, covered with coarse emery powder, is dropped into the supports, V¹, screwed to each side of the machine (figs. 1, 4, and 5). This emery roller is about 8 inches diameter; and whilst being rotated in contact with the main drum, and in the same direction as the drum, it reciprocates longitudinally, so as to present a constantly changing surface to the teeth of the drum. The drum, whilst being ground, should be rapidly rotated in the opposite direction to the inclination of its card teeth. The doffer card, B¹, is generally ground at the same time as the main drum, one strap being employed for driving both the emery rollers. The workers and clearers are ground on a special machine by a large emery stone of a length rather greater than the cylinders to be ground. Two or three cylinders may be thus ground simultaneously, a longitudinal reciprocating motion being at the same time imparted to the emery stone. The flat top cards are also ground in a special self-acting machine by a large emery cylinder, the tops being fitted into a double carriage, containing two top cards, the one in front and the other in the rear of the emery cylinder. This carriage has a vertical reciprocating motion imparted to it, whilst the emery cylinder receives a horizontal reciprocating motion.

The cleansing of the top cards, in order to keep them in good working order, is a most important desideratum; and several self-acting mechanical strippers are now in use, chiefly applicable to flat tops, which may be classified under three systems.

The first and the oldest is that which, without changing the tops, consists in elevating mechanically, one after the other, each top a short distance, and causing a comb to pass beneath it at the proper time, the object of which is to remove the dirt attached to the teeth of the card clothing. This system was invented by M. Dannery, of Rouen, in 1844. M. Risler de Cernay effected the mechanical stripping of the tops on somewhat the same principle, by appliances operated by means of Jacquard mechanism.

The second system consists in substituting for the flat tops, cylinders provided with teeth, and receiving a slow motion, which, by self-acting means, are exposed in order to submit them to the action of the stripping comb for the removal of the waste and extraneous matter with which their teeth become clogged.

The third system is that adopted by Messrs. Platt, which consists of an endless chain, each link of which forms a top furnished with card teeth; guide rollers, provided with notches corresponding to pins in the chain, draw the chain forward so as to move it at the speed most convenient to avoid the clogging of the card teeth.

The automatic stripper of Mr. G. Wellman, shown in Plates 4 and 5, applied to the carding engine of Messrs. Schlumberger & Co., is similar in principle to that of M. Dannery; it differs from it, however, in some of the details of construction, and in certain modifications which insure its efficient working. This ingenious contrivance was patented in this country by Mr. J. H. Johnson, of 47 Lincoln's Inn Fields, in 1853, 1856, and 1860, and has already been noticed briefly in our pages.*

Mr. Wellman's apparatus is shown attached in figs. 1, 2, 3, and 4. Fig. 12 (Plate 4) is a side elevation of the same apparatus detached, as seen from the inside of the carding engine; fig. 13 is a vertical section at right angles to fig. 12; and fig. 14 is a plan of the cam gearing, which produces all the desired motions for effecting the mechanical stripping. These motions have for their object:—1st, To elevate successively each of the tops at fixed periods in the direction of the radius of the drum. 2nd, To pass a stripping surface under the card teeth of the top when elevated. 3rd, A radial motion of the whole of the stripping apparatus, which stops successively before each alternate top on starting, and before each alternate one on returning, in order to effect the perfect stripping of the whole of the tops in going and returning.

It is on the main frame, A, of the carding engine that the cast-iron arches, F, are secured, which support the series of tops, and also the two double racks, Q¹, at each side of the machine. The shaft, B², of the large drum supports at its two extremities the oscillating frame composed of the two vertical arms, S¹ and S², and the cross piece, S³, which frame carries with it the stripping apparatus. The extremities of the arms of this frame are secured to a strong spring, G², attached, as is shown in figs. 1 and 4, to the lower part of the frame of the carding engine, in such a manner as to counterbalance the weight of the oscillating frame and the parts connected with it.

The tops, F, are numbered from 1 to 10, in the ordinary manner, commencing from the doffer card, B¹.

As the mechanism is the same at each side of the carding engine, it will only be necessary to describe one of such sides.

The principal agent for the transmission of motion to this apparatus consists of the tooth wheel, T, which is cast with two interior grooves independent of each other, so as to cause each to fulfil the office of a cam. These grooves transmit all the motions necessary for lifting and cleaning the tops, and for causing the oscillating frame to pass from one top to another. The groove of the internal cam, *t* (fig. 12), receives the pin, *x*, fixed to the rectangular piece, X, which slides in a groove made for this purpose in the oscillating arm, S¹. This piece, X, terminates in a species of jaw (fig. 13), the object of which, when being elevated by the action of the cam, *t*, is to engage it with the extremity of the top, so as to be able to raise and maintain it in position while the stripping is being effected, and then to return it to its place. For this purpose a mortise is formed in each end of the tops, and receives a guide, V, fixed to the oscillating arms; it is by the aid of these guides that the top remains attached to the oscillating frame so long as the jaws, X, are kept elevated. In the groove of the external cam, *t*, there engages the pin, *v*, which has its axis on an appendage of the lever, V. This lever, assisted by the similar lever placed at the other side of the machine, is intended to support and actuate the stripping surface, q^1. The lever, V, is jointed to the oscillating arm, S¹, by means of a pin engaged in a groove, in such a manner that it may be moved with facility, and that the height of the stripping surface may be adjusted at pleasure. The internal cam, *t*, intended, as has been shown, to elevate the top by the medium of the jaw, X, and the external cam, t^1, with its stripping lever, are proportioned and regulated in relation to each other, so that the top may remain raised to its full height during a sufficient length of time for the stripping lever to carry forward, under the raised top, the stripping surface, q^1, and to maintain this surface stationary until the continued motion of the internal cam slightly lowers the top, in order to engage its teeth with those of the stripping surface; and finally, that the top may remain in this position whilst the stripping surface is withdrawn, thereby removing from the top the dirt and knots adhering thereto. In order to receive these wastes, a curved plate of sheet iron, W, is inserted behind the stripping surface, and follows all its movements. As this receptacle is soon filled, it requires to be cleaned out from time to time, in order to avoid the accumulation of the waste on the machine. After the operation of stripping by the surface, q^1, the downward motion of the jaws, X, returns the top to its normal position; its descent is moreover assisted by the springs, q^2, fixed to the cross-piece, s^3, of the oscillating frame, which are slightly compressed at the time of the ascent of the jaws. The edge of the wheel, T, is provided on its entire periphery with teeth, by which motion is communicated to it; to this series of teeth there is added another series, t^2 (figs. 13 and 14), forming a segment of the wheel and a smooth rim, V¹. The number of teeth of the segment, t^2, is sufficient to cause the pinion, *u*, to make a complete revolution, after which the latter remains stationary under the influence of the plate, *q*, which presses against it, and presents a concave surface to the rim, V, of the cam wheel. The axis of this pinion, *u*, is supported by the extremity of the lever, T¹, on the same centre as the cam wheel; it carries also a second pinion, u^1, of a smaller diameter, which gears with the double rack, Q¹. This axis continued, carries also a small friction roller, which enters a groove completely surrounding the teeth of the double rack; it serves as a guide and partial support to the pinion, u^1, when turning the ends of the two series of teeth in the double racks. The double rack, Q¹, and the pinion, u^1, are arranged in such a way that one revolution of the pinion is just sufficient to take the oscillating frame from one top, not to the immediately succeeding top, but to the alternate top; that is to say, to cause it to pass from No. 1 to No. 3 top, and so on, stopping at each odd top, until it arrives at the last, near the working cylinders. The pinion, u^1, in turning round the last tooth of the double rack, Q¹, loses a half-turn, in order to pass from the upper

* See *P. M. J.*, vol. vi., First Series, p. 245; also vol. vi., Second Series, p. 155.

to the under side of the rack, and *vice versa;* consequently the pinion has only a half-revolution to make in order to act on the teeth of the double rack, which is just sufficient to take the oscillating frame to the third top instead of to the second. The direction of the motion is changed at the same time, and the stripper then stops at each even number in its return course back to the commencement of the series of tops.

In order to insure the parallelism, the mechanism placed at the opposite side of the carding engine is exactly the same as that above described, and operates simultaneously. Both series of mechanism are actuated by the pinions, x^1 (figs. 1 to 3), which gear with the cam wheels, T. These pinions are fixed on the axis, X^1, which receives motion by means of the toothed wheel, Y, fixed thereon, and gearing with the small pinion, *y* (fig. 3), the axis of which carries the pulley, *z*; a strap shown in dotted lines (fig. 3) embraces this pulley, and also the pulley, *z* (figs. 2 and 4), fixed at the extremity of the principal shaft, B^2, on which the main carding drum is mounted. By this mode of transmitting the motion the two cam wheels receive simultaneously a continuous rotatory motion, whatever may be the position occupied by the oscillating frame, and even during its movement.

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RECENT PATENTS.

SEWING MACHINES.

THOMAS HENDERSON, *Glasgow.—Patent dated November* 1, 1866.

THE improvements embodied under this invention consist essentially in constructing the feed arrangement in that class of machines known as elliptical sewing machines, so that the feeding teeth are situated both in front and back of the needle, by which arrangement a more perfect feed is obtained than hitherto. Another improvement consists in driving the needle arm by eccentric motion, the eccentric being placed on a shaft driven by a belt underneath the table; whilst a third improvement consists in governing the motion of what is known as the elliptic hook by a piston or plunger, working in a cylinder instead of a connecting rod, whereby greater steadiness of motion is obtained. Another part of this invention consists in the bobbin holder being fixed to the front instead of at the side, by which arrangement the bobbin is more easily got at for removal or replacement.

Fig. 1.

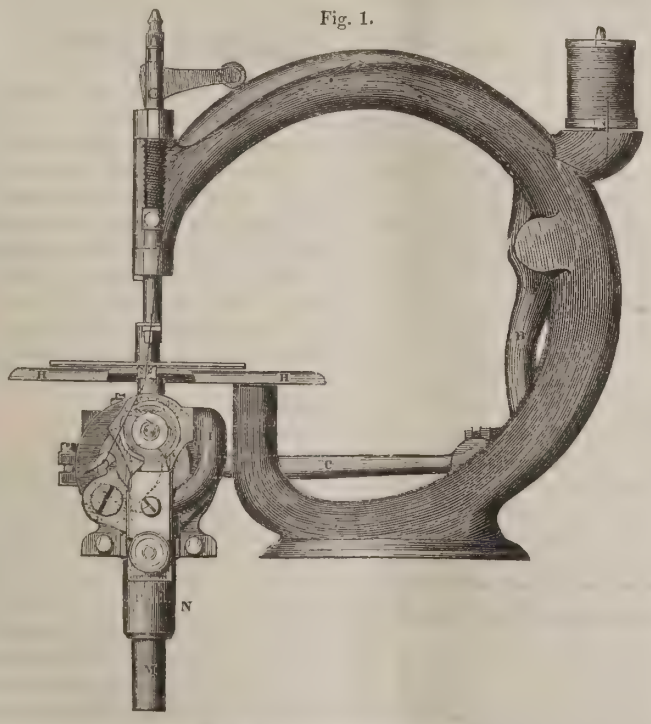
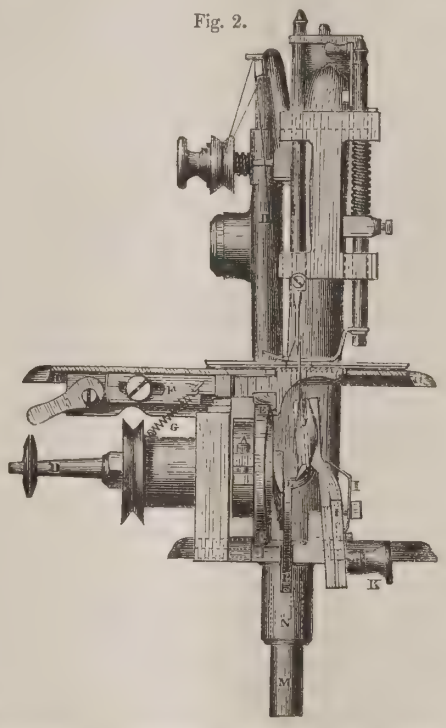


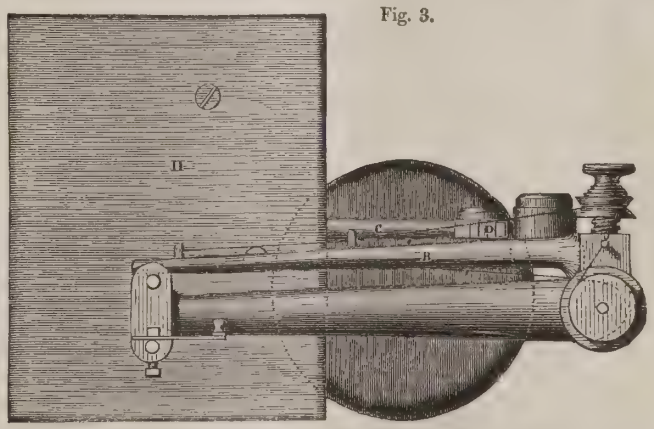
Fig. 1 is a side elevation, fig. 2 a front elevation, and fig. 3 a plan of the elliptic sewing machine constructed in accordance with the present improvements, which consist in applying the eccentric, A, for giving the necessary vibratory motion to the needle lever, B, through the medium of the eccentric rod, C. On the shaft, D, carrying the eccentric, A, the feed cam, E, is situated. This cam is made of the

Fig. 2.



form shown at fig. 2; so that as the thickest part of the cam passes through the upper half of its revolution, it carries back the feed bar, F, and at the same time lifts it by means of the periphery at one part of the cam being slightly elevated, or being of larger diameter. As the feed bar is thus lifted, the notches, *a a*, figs. 1 and 2, catch in the cloth; and as the revolution is continued, the thick edge of the cam descends in its revolution, whilst the thin half ascends so that the feed bar, F, is free to be moved horizontally by an amount corresponding to the

Fig. 3.



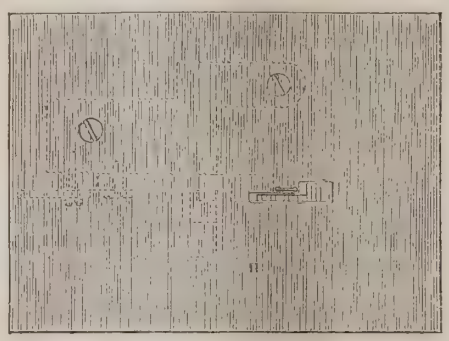
inclination of the oblique side of the cam. The spiral spring, G, pulls the feed bar constantly, and it is thereby maintained in constant contact with the cam. When the feed bar arrives at the left hand end of its stroke, that part of the cam which is of smallest diameter acts upon the lever; the lever, therefore, descends below the level of the table, H, and is therefore out of contact with the cloth; and the cam, on being revolved further round, carries the feed bar to the right hand end of its stroke; and as it approaches to the end of that stroke, the thick part of the cam again coming uppermost lifts the feed bar to catch the cloth for the next onward movement. The feed notches, *a a*, principally

situated behind the needle, in place of before it as hitherto, enable the cloth or work to be drawn through with greater smoothness, and also prevent puckering.

The bobbin holder consists of the framework, I, to which the spring, I′, is attached, the pressure produced by which keeps the bobbin, J, in place. This can at any time be removed by merely withdrawing or unscrewing the thumb nut, K, by which it is held in place.

The hook, L, for forming the stitch is secured to the crank by a screw pin, as shown at figs. 1 and 2, and its lower end is jointed to the piston or guide rod, M, which, as the machine is at work, is reciprocated upwards and downwards in the cylindrical guide socket, N. In this way an exceedingly steady movement of the hook is obtained, and it is

Fig. 4.



not liable to miss stitches after the machine has been much worked. When the feed bobbin requires to be refilled the holder is detached, and the bobbin being then taken out is placed on the taper shaft, as shown at fig. 2; the shaft being rotated the thread is rapidly wound thereon. By this arrangement the use of a bobbin winder, as hitherto adopted with "elliptical" sewing machines, is dispensed with.

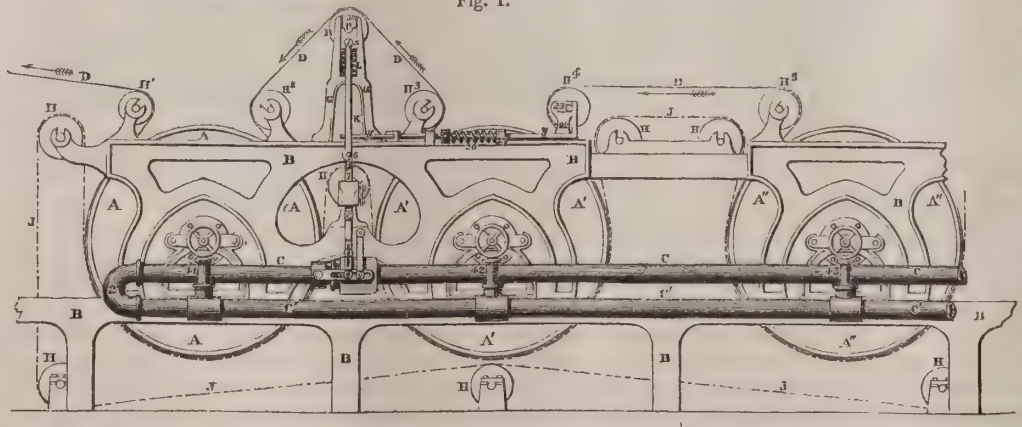
By the foregoing arrangements, the framework which carries the mechanism, as well as the stationary arm, are capable of being cast all in one piece, so that there cannot be any disarrangement or shifting of any of the parts out of their working positions. To avoid misapprehension as to the term "elliptical" sewing machines, it is now explained that it is the name applied to those machines in which the hook, L, being extended beyond the crank centre, moves through each revolution in the path of an ellipse.

PAPER-MAKING MACHINERY.

J. Henry Johnson, *London and Glasgow.—Communicated by* Richard Smith, *of Sherbrooke, Canada East, and* Oliver Ellsworth, *of Boston, U.S., A.—Patent dated 23rd October*, 1866.

This invention relates to a mode of regulating the drying of machine-made paper whilst it is passing from the pulp reservoir, to and around

Fig. 1.



the series of copper cylinders used for drying it, this being accomplished by admitting more or less steam to the drying cylinders; the admission or exclusion of the steam being dependent upon, and proportional to, the moisture or dryness of the paper.

It is well known that paper contracts as it dries, and increases in size when it is wet; this change taking place both in its length and breadth. The change in the length of a part of the web or sheet of paper, resulting from its hygrometric condition, constitutes the active power or force that is used in the present invention for producing an automatic apparatus, which maintains the exact degree of heat that is requisite for drying the paper.

A part of the machine is so constructed that the accidental breaking of the web or sheet of paper moves an arm that causes the steam valve to retain its position until the paper is again adjusted.

Fig. 2.

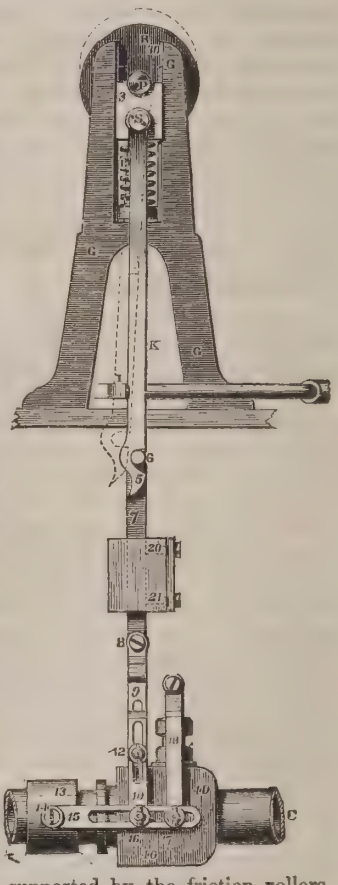


Fig. 1 of the annexed engravings is a side elevation of a machine for making paper; fig. 2 is an elevation of the roller, R, and its connections, with the steam valve; fig. 3 represents the horizontal draw-bar and let-off motion, to operate the vertical bar, K.

The main frame of the machine is represented at B, and the steam-drying cylinders at A, A′, A″. The steam by which the drying cylinders are heated is supplied from a steam boiler through a horizontal pipe, which is attached to one side of the machine. At a convenient point in this pipe, midway between the two steam cylinders, A and A′, a balance valve is inserted, which governs the quantity of steam that is allowed to enter the cylinders from a second horizontal pipe, which is connected to the first pipe by a half turn, and has, at a point opposite to the centre of each of the cylinders, A, A′, A″, short vertical branch pipes that afford a passage through which the steam enters each cylinder, suitable fittings and stuffing boxes being used to insure a steam-tight joint.

The endless apron, or "felt," represented passing partially around the steam cylinder, is guided and supported by the friction rollers, H, H′, H″, attached to the framing, B, in suitable positions.

The sheet or web of paper, D, traverses in the direction of the arrows, in contact with the steam-drying cylinders for a part of its length, while at other parts it is raised from the felt, or apron, and passes around the friction rollers, H^2, R, H^3. It is at these points, where the paper is not in contact with the steam cylinders, that the variable length of the paper, caused by its hygrometric condition, is made to govern the admission or exclusion of steam, and consequently to impart greater or less heat to the surface of the cylinders.

This is effected as follows:—Between the stationary rollers there is an elevated movable roller, having its axle supported in a box or bearing, which rises and falls in a slot or recess formed in the top of the standards. Below the box there is a spiral spring, and on its front side a stud and screw supports a pendulum lever or arm, K. This arm has a hook or catch at its lower end, which engages with a stud that projects from the side of a vertical rod, jointed to another vertical rod, which connects with a slotted adjusting rod; the position of which can be varied, and the length of the combined rods adjusted by means of a set-screw. A collar is attached to the steam supply pipe, and carries a

centre pin from which extends a horizontal slotted arm or lever, near the middle of which the end of the combined vertical rod is attached by a set-screw; and at its free end another rod, connected with the steam valve, is fastened by another set-screw, and opens or closes; and as it rises and falls, gives motion to the valves within the steam pipe. One part of the vertical rod plays through a guide-box provided with bearing springs.

The position of the vertical rods and the throttle valve are adjusted experimentally, so as to give the mean or average required temperature to the drying cylinders. Any subsequent excess of heat is shown in the contraction of the paper. This causes the movable roller to descend, shutting off the excess of steam by the action of the connecting rod, K, and connecting rods before referred to of the throttle valve. If the paper becomes damp, the length of the part that is passing from the roller, H^2, to the roller, H^3, is increased; this allows the roller to be raised by the action of spiral springs under the bearings at each end of

Fig. 3.

the roller; the connecting rod also rises, opens the valve, and admits more steam, which increases the heat of the cylinders, dries the paper and shortens it, thus restoring it to its normal condition.

In case the paper be accidentally broken, the strain upon all the rollers is reduced, and the roller would rise and admit too much steam to the cylinders, were not special provision made for retaining the steam valve in the position it occupies when the paper breaks.

This part of the apparatus is situated upon the top of the main framing, and is constructed as follows:—The paper, after leaving the roller, H^5, passes around the rollers, and thence to the steam cylinder, A′. In the stand that supports the roller, H^4, there is a horizontal slot which forms an elongated bearing for the axis of the roller, which is retained, by the tension of the paper, on the right side of the slot, as represented in fig. 1. The end of the axis or shaft projects beyond the slot, and is in contact with a short upright arm on a horizontal shipper rod. Near the middle of this shipper rod there is a spring under tension so long as the short arm is held back by the strain of the paper. When the paper is broken, the spring reacts against the fixed stud; the rod is thrown forward, and disconnects the hook at the lower end of the pendulum arm from the pin, leaving it in the position represented by the lines in fig. 2; this leaves the roller free to rise, without opening the steam valve.

When the paper is replaced, that part of the sheet between the rollers, H^2 and H^3, becomes dry and depresses the roller, causing the catch or hook on the pendulum rod to engage with the pin, and restore the connection with the throttle valve. This mechanism causes the drying cylinders to remain at nearly a uniform temperature during the time occupied in replacing the paper, in readiness to form a continuous sheet.

SAFETY FUZES.

James Harebooth Gresham, *Hull.—Communicated from* W. R. Whitehorn, *of Melbourne.—Patent dated October* 26, 1866.

This invention relates to the manufacture of an improved safety fuze which the inventor terms the "Britannia Safety Fuze," for the use of miners, quarrymen, and others employed in blasting rocks and hard minerals, whereby a more certain and less costly method of firing the charge of powder is secured; also to certain peculiar constructions and arrangements of machinery apparatus, or means for manufacturing the safety fuzes.

This improved safety fuze consists of a central "core" composed of a number of threads of fibrous material which have been steeped in or passed through a solution of saltpetre, and which are then twisted together so as to inclose within them a continuous column or train of gunpowder. The surface of this "core" is then coated with pitch, tar, or similar material, and is covered with strips of paper or other suitable material, such as felt; but it is preferred to employ a stout brown paper similar to the material known to bookbinders as "tip-board." These strips are previously accurately cut to a width of exactly half the circumference of the fuze, and each strip is moulded into a semicircular trough shape, so that when the edges are brought together they form a paper tube having two longitudinal slits on diametrically opposite sides thereof, which tube incloses the core. The core and case now joined together and cemented with the pitch, tar, or like composition, are lapped or wound round at an angle with one or more strips of calico or other woven fabric, in substitution for the tape heretofore employed, in order to bind the whole together. The fuze is then passed through a bath of pitch or tar to give it the final waterproofing coat, and then through a trough of plaster of Paris previous to being coiled and packed for sale. The machinery employed in the manufacture of the "Britannia Safety Fuze" consists of a powder canister of any required dimensions fitted to the centre of a revolving horizontal disc, and provided at its lower end with a nozzle having a number of slits or openings in its sides; through these slits or openings are passed the threads to be twisted together, which have been previously saturated by a strong solution of saltpetre, as before described. These threads are supplied from reels or bobbins carried by the revolving disc before referred to. A vertical tube attached to the centre of the bottom of the nozzle, and descending some distance, serves to receive the converging threads as fast as they become twisted together, the twist being obtained by imparting a rotatory motion to the disc, with its bobbins, powder canister, and nozzle, by the aid of a driving pulley and band. As the interior of the nozzle is kept supplied with gunpowder from the canister, it follows that the threads as they pass through the powder will continuously take up any amount of powder proportionate to their size and number. As fast as the "core" is formed it is drawn through the tube by a grooved drawing roller or pulley, receiving a positive motion, and having the core passed one or more times round its circumference. The core thus formed is wound upon a reel, which, when full, is conveyed to the machine for coating the core and applying the paper covering. This machine consists of two uprights, carrying at the upper ends in suitable bearings the reel of core, whilst two other reels, situate one on each side of the uprights, carry the two narrow strips of paper for inclosing or covering the core. The core itself, as well as the two strips of paper, converge into a bath or vessel of melted pitch, and pass together through a suitable aperture in the bottom thereof, the paper and core being thus coated with pitch and united together at the same time.

Fig. 1.

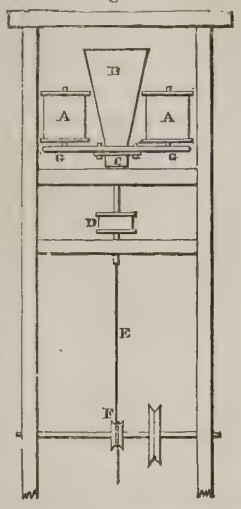


Fig. 2.

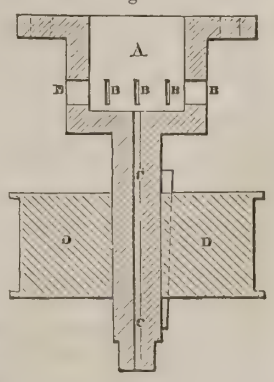
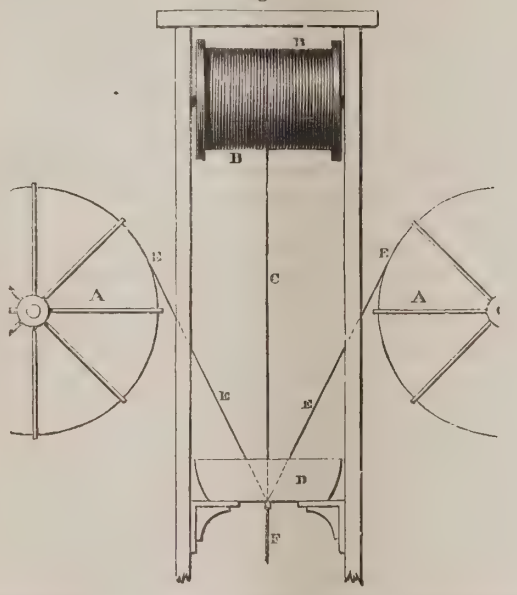


Fig. 1 of the annexed engravings represents an elevation of the "core machine," and fig. 2 is an enlarged detail section of the nozzle of such machine detached. B (fig. 1) is a powder canister of the required dimensions, provided at its lower end with a nozzle, C, which nozzle is shown full size at A (fig. 2). A number of threads previously soaked in a strong solution of saltpetre are led from reels, A (fig. 1), into this nozzle through the slotted holes, B B (fig. 2), which threads converge towards the centre of the nozzle, and are drawn through the gunpowder contained therein, and down a tube or hollow spindle, marked C in fig. 2. This tube should be of the required size to regulate the supply of powder necessary to be taken through with the threads. By this means the threads carry in their downward passage a column of powder proportionate to the size or number of the threads employed, and to the internal diameter of the tube, C. The powder canister, B, and the thread reels, A A (fig. 1), are attached to a revolving disc, G, which receives a rotatory motion, either from a band passing round the sheave, D, or by any other suitable contrivance. This rotatory motion of the reels with the powder canister and nozzle has

the effect of twisting the several threads or filaments employed into a perfect cord, containing an unbroken column of gunpowder in the centre thereof. The cord thus formed with the column of gunpowder contained therein is termed the "core;" it is wound upon a reel or core drum, shown at B in fig. 3, which represents an elevation of the casing machine. In this machine the paper covering or casing is applied to the core in the following manner:—The core is unwound from the drum, B, and passed through a vessel, D, containing a composition of pitch and tar, which is kept in a liquid state by the application of heat thereto in any convenient manner. A conical tube, *d*, passes through the bottom of this vessel, the internal diameter of such tube being equal to the external diameter of the fuze, which passes through this tube. During its progress through the tube, *d*, and just as it enters therein, the core is joined by two strips, E E, of stout brown paper, similar to the material known to bookbinders as "tipboard," or, in lieu thereof, felt or other suitable material may be employed. These strips, which are supplied from the reels, A A, have previously been accurately cut by suitable and well-known machinery to a width equal to exactly half

Fig. 3.



the circumference of the fuze, and each strip is moulded as it enters the mouth of the tube, *d*, into a trough of semicylindrical form, so that when the edges of the opposite strips are brought together, the two united strips will form a perfect tube, having a longitudinal slit or junction on diametrically opposite sides thereof. The core and case thus united together, as shown at F, and cemented with the composition contained in the vessel, D, are lapped or wound round at an angle, so as to produce a spiral lapping, with one or more strips of calico, or other woven fabric, in order to bind the whole together, such lapping being applied in a similar manner to the ordinary tape lapping on the tape fuzes at present in use. The fuze now made is passed through a bath of a similar composition to that hereinbefore described, in order to give it the final waterproofing coat, and lastly through a trough of plaster of Paris previous to being coiled and packed for sale.

The peculiar advantages afforded by the "Britannia Fuze" hereinbefore described are—1st. An unbroken column of powder obtained by the drawing of twine or threads through a "nozzle" containing gunpowder, as shown in fig. 2, whereby freedom from the dangerous and often fatal consequences resulting from the fuze hanging fire is insured. 2nd. A tough homogeneous and impervious casing of such a character as to provide against damage resulting from careless tamping or from heat or moisture. 3rd. Cheap material and simple machinery, thereby considerably reducing the cost to the consumers.

REVIEWS OF NEW BOOKS.

LIFE AND WORK AT THE GREAT PYRAMID DURING THE MONTHS OF JANUARY, FEBRUARY, MARCH, AND APRIL, A.D. 1865; WITH A DISCUSSION OF THE FACTS ASCERTAINED. By C. PIAZZI SMYTH, F.R.S.S. L. and E., Astronomer Royal for Scotland, &c. 3 vols. cloth; with illustrations on stone and wood. Edinburgh: Edmonston & Douglas.

FIRST NOTICE.

To those minds who have prepared themselves by honest investigation to appreciate the magnitude of the subject treated, the immensity of the labour which the Scottish Astronomer Royal has devolved upon himself will appear by no means incommensurate with the transcendent importance of those teachings which the Great Pyramid was no doubt the first material embodiment of, as an index in the direction of Truth, to the ancient races, or possibly some particular race that inhabited Egypt, and not improbably intended for the benefit of mankind through all time after. We fear, however, that the views taken and the magisterial manner in which they are discussed, are too far different from what has hitherto been generally adopted—that the number of readers is small who will yield up a creed they had formerly received, and substitute another, to the necessary understanding of which none of the ordinary modes of book-reading will suffice. To many minds we would fain recommend the subject; but when we consider by how few it would be honestly dealt with, we must leave the surplus shut up in those prejudices as blindly as have been the facts of the great structure itself from a period without date. This nineteenth century, however, has brought to light much of the real state of things common in ancient Egypt; and with this growth of knowledge men of science have devoted their energies, their time and fortune—amongst whom in particular is the author, whose recent work we are about to consider—in bringing to light numberless realities concerning the Great Pyramid itself. What the painstaking application of modern mathematical and physical science has done we shall afterwards see.

Egypt truly has been styled the *Land of Monuments;* but what are they any or all structurally, in comparison with the Great Pyramid? Then for what purpose could all this distinction of construction and workmanship, with such accuracy in every detail of consequence, that it would be difficult with all the available capital of the present day to imitate, have been adopted? Men may rest assured there is a meaning resident there which they have not heard of yet. They have been accustomed to contemplate, admire, and wonder at the gorgeous ruins of temples, palaces, and the lofty monoliths covered with hieroglyphics, at Luxor, Dendera, and Ebsamboul; the stupendous man-made lake of Moeris, as well as its canal of entrance from the Nile, the former of which Herodotus, as well as Diodorus Siculus, tell us was 3600 stadii = 450 miles in circumference, that it stretched from north to south, and that its greatest depth was about 300 feet—whilst Pomponius Mela states it to have been 500 miles in circumference; the Labyrinth contiguous thereto, as well as the temple of Antœopolis, the northern gate of Dendera, the temple at Edfou, and its walls emblazoned with the largest of colossal sculptures; the tomb and palace of Sesostris, as well as the temple of Hermonthis; together with the huge Andro-Sphynx at Jeezeh, and the hosts of tombs with their sepulchral contents of mummies, idols, jewels, spices, and other precious things. Yes, our race has undermined, brought to light, and dishonestly robbed much of the *mirabilia* of that ancient people's pomp and splendour, and no difficulty has been experienced in pronouncing the intent of all such things, and in all probability the true meaning of the second, third, and all the dozens of lesser pyramids too; but when directed to discovering why the Great Pyramid was built, it may truly be said that until of late the sagacity of all Egyptologists has proved awanting; its features, so distinct from all its congeners, its gigantic dimensions, its wondrous and equally majestic internal splendour, its superior and even exquisite finish, the deep mysteries of its origin, and the hitherto inscrutable destiny of its purpose, have dumbfoundered all investigators.

It is not our purpose here to discuss all the solutions to the problem that have been offered; the accurate applications of modern mathematical science have shown at once the unreasonableness and absurdity of those theories, which propose that it, as well as some of the other pyramids, were intended as places of refuge in the event of a second deluge; nor that they were granaries in which Joseph stored the corn

during the seven years' famine; nor that they were temples; nor that they were observatories, which certainly they were not, although possessing, it is true, some peculiar features tending towards astronomical practice; nor that *they* were the imposed work on the people of Egypt by a dynasty of oppressive kings. That all the pyramids, except the "great one," were places of sepulture for the ancient kings of the idolatrous Egyptians, is almost beyond question; and to review this new theory of the largest of the pyramids—the Pyramid of Cheops, as it is generally known—is now our purpose.

Numerous measurements of parts of the Great Pyramid had been made from the time of Bellonius, A.D. 1553; Sandys, A.D. 1610; Greaves, A.D. 1638; Jomard, A.D. 1799; Sir Gardner Wilkinson, 1831; the whole of which are so strangely diverse in all the values they give, that they are useless in assisting to form any geometrical theory of the structure. We are indebted, then, to Colonel Howard Vyse for his most unselfish and laudatory expenditure of fortune and time in 1837, as having taken the initial steps in obtaining more exact measures with the assistance that modern observing instruments afforded him; also in organizing his staff of Arab labourers, whose excavations disclosed those facts which enabled the late John Taylor to lay the foundation stone of the theory which Professor Smyth has so much advanced.

Herodotus, as well as Strabo, Pliny, and many early Arabian authors, how saw the Pyramid in its original state, all describe it as covered with a white stone casing, eminently smooth and beautiful; however, for nearly two centuries, on account of the fact of no such covering having been seen by modern travellers, the report of those ancient and usually exact writers was discredited, notwithstanding that so much of a similar casing still remains covering the upper half of the second pyramid. Indeed, as it is elsewhere written, "the keystone of the whole theory of the Pyramid would have been entirely awanting, but for Colonel Howard Vyse's most providential finding of two "casing stones" *in situ*.

Up to that time all ideas of the angle which the original side formed with the plane of the base, even the very learned attempts of the French academicians in 1799, were but guesses; and have turned out since to have been so far from the truth as to be utterly incapable of maintaining the true geometrical theory. This exquisite polished casing of the white limestone from the Mokattam hills the Kaliphs of Egypt began to strip off about the year 1000; and to furnish some better idea of the masses of material so ruthlessly stolen away, we may mention that they built two bridges to convey them across the Nile, and employed them at El Káhireh to build the palaces, mosques, and the lining of the great "Yoosef" well, which still adorn that city. In their devastation, however, they did not complete the spoliation, as four of the lowest tier of casing stones were left untouched; they, however, some centuries afterwards, succeeded to extract two of these from under the hill of sand and rubbish that accumulated around the Pyramid's base. The other two, however, were still allowed to remain; and in their original position they were discovered by Howard Vyse firmly cemented to the rock platform of the Pyramid Hill, thus unmistakably pointing out to the denizens of the nineteenth century what was once the true nature of the outside of the Pyramid; proving, too, the faithfulness of the record given by Herodotus, Strabo, Pliny, and the Arabian writers.

A grand triumph indeed was this discovery of the Colonel's! worthy of his own genuine honesty and devotion of purpose; worthy, too, of the nation to which he belonged, as another proof of that determination so often shown, of Anglo-Saxon energy not resting content on assumptions and reports, but plodding, persevering through till hearsay is proved true or proved as undeniably false. Wherever Great Pyramid research or literature may ever reach, the name of Howard Vyse must always go along with it under mention the most honourable; and we have pleasure in here rendering our tribute of appreciation to what he so nobly did. Let those of our readers who dwell on these lines, if possible, and as soon as possible, if they have any inkling towards that ruined land of majestic grandeur, and at first so supremely favoured, read in a right frame of mind those volumes which the Colonel has written.

To return to the casing stones. We may truly admire them, not alone for their size, but for the matchless workmanship they exhibit; as true as the truest work of modern instrument makers. May we not well admire masonry joints, of a height of 5 feet and a length of 8, so close, the surfaces so correctly true with each other, that the cement uniting them was of no greater thickness than a sheet of paper. Men, modern men, may look amazed and doubt, as many have done and still do; nevertheless, the assertions are facts undeniable—

* * * "The base is sure;
Fix'd in the rolling flood of endless years,
The pillar of th' eternal plan appears."

Notwithstanding the Colonel's determined conduct in prosecution, his research of condition, the engineers he had with him were not so accurate in determining the true angle of the Pyramid's sides. The angle as measured came out 51° 50′; and being computed from linear measures of the side, it showed 51° 52′ 15·5″, results certainly very close, but not reliable, as we shall afterwards see; although so extremely close to the true angle of 51° 51′ 14·3″, recently measured by Professor Smyth, that no objection can be taken to it as being one of the standpoints from which Mr. Taylor was able to start his geometrical theory. We shall show in another notice how this angle was obtained, it being beyond our limits of a single notice to enter into a point of this nature, that requires so much discussion. Suffice it now to say, Mr. Taylor's first proposition is, that the vertical height of the pyramid is to twice the length of any one side of its base (this being square) in the exact ratio of the diameter of a circle to its circumference; or, numerically, the original height (vertical) of the pyramid being 486 feet, and its base being 764 feet,

$$486 : 2 \times 764 :: 1 : 3{\cdot}144;$$

or, performing the multiplication,

$$486 : 1528 :: 1 : 3{\cdot}144.$$

This most striking coincidence is no less true than the material embodiment of the other geometrical facts, about which we shall treat further anon.

In what we have said our readers will discover that as yet we have made but little allusion to Professor Smyth's new work; we merely add here that it is written partly as the result of a four months' personal investigation at the Pyramid, although most of the propositions were reasoned out by Professor Smyth for some considerable time beforehand, and published by him anteriorly to his visit;* and it is remarkable to find how near to the truth, so far as measurements and comparisons are concerned, the nature of things at the Pyramid accord with theory, although there can be little doubt that the further application of deductive science may yet discern certain other analogies that have not yet been surmised, and probably alter some of those now propounded. That one, if not the only, purpose of the Great Pyramid was to serve mankind as a monument of metrology, we think there is little room to doubt. In future Parts of this Journal we shall endeavour to show our reasons for this belief. As to the book itself, its first volume is the most charming account of a scientific expedition in search of truth that we have ever met with; the second principally consists of a series of tabulated results, as well as a meteorological table at the Pyramids, kept during the four months' life in the tombs; whilst the third, which is by far, to the well trained mind, the most interesting of the whole, is a discussion and generalization of the whole theory. The work is printed in excellent type, and altogether reflects much credit on the publishers from the handsome style in which it has been produced. Time and the limits of our space press on us now; we therefore rest till next issue.—V. D.

THE TEXTILE MANUFACTURES AND THE COSTUMES OF THE PEOPLE OF INDIA. By J. FORBES WATSON, M.D., F.R.A.S., &c., Reporter on the Products of India to the Secretary of State for India in Council. 1 vol. folio, illustrated. Printed for the India Office. 1866.

THIS elaborate work ought to do good service by pointing out the only true paths by which our own cotton and other manufacturers at home may search and establish a great commerce with India by clothing a larger section of its people. Two hundred millions of souls wanting clothing, mainly of cotton, for their bodies, is, one would think, a sufficient incentive to cause our calico weavers and printers to set their shoulders to the task, first of finding out how it is that their products are generally rejected by the natives of India, and then of redressing the anomaly that, with all our machinery and division of labour and motive power, the Indian people, though neither an energetic or industrious, nor a manufacturing people, yet after all our years of occupation and dominance in the country, still clothe themselves.

* *Vide* "Our Inheritance in the Great Pyramid." Strahan. 1864.

We confess we have not very sanguine hopes as to any great change in this respect. The secret is fully developed by Dr. Forbes Watson, who shows plainly that to succeed in creating an Indian textile market we must not only consult the ancient and, as we may say, sacred habits and customs of the people as to the nature and configuration of their clothing, but we must consult their taste. As regards the former, peoples who for countless ages have worn garments "woven and without seam, and of one piece throughout," like that coat for which the soldiers, rather than rend it, cast lots whose it should be, will not be coerced, even were it possible to bring fiscal considerations to bear upon them, into wearing half-yard or yard wide Manchester cloth sewn up by a sewing machine. To some the seamed cloth is a religious abomination. As regards the matter of taste, it may be said at once that the taste of Orientals in pattern and in colour is at once marked, distinctive, peculiar, and is admitted by the eye of culture and fine art in Europe to be, in one word, in general exquisite. As regards *colour*, nothing that we can produce in Europe, nothing even that Lyons in its silks, or Mulhausen in its finest printed woollens or cottons, has ever produced, is to be named beside the incommunicable beauty, purity, brilliancy, and harmony of many of the Indian fabrics; and although this is most strikingly true of the highest class, and of most expensive fabrics, such as the shawls and woollens of Cashmere, it is by no means confined to these. These glorious tints we shall probably never be able to equal in Europe, because, all other reasons apart, we have not the *sunlight*, which is no doubt one of the elements upon which the perfection of Indian dyes depends. But unless our manufacturers will turn over a new leaf, and endeavour to make clothing such as the native Indians like, rather than to force them to wear Manchester tawdry prints which they abhor, the grand mercantile prize of clothing two hundred millions of people—one-sixth of the whole of the inhabitants of the globe—must remain to them as distant as ever. Were some great man in the cotton print trade to arise now, and be to it what Wedgewood was to the earthenware trade of his day in England, the thing would in all likelihood be achieved. However, Dr. F. Watson has in this volume shown the way, and has ably, therefore, accomplished his part. It is for the manufacturer to follow the lead he indicates. This work is, in one sense, a consequence of the great Exhibitions of 1851 and 1862, and is one instance of the good they have accomplished, or may yet accomplish.

Of the vast collection of native fabrics there made, specimen pieces, so selected as not only to show pattern and colour, but the nature of the textile structure of no less than 700 different native cloths, of all sorts and values, have been cut from the pieces and bound into volumes, with descriptive references. Of these, twenty complete sets have been made up, which are in fact twenty industrial museums, prepared in the best manner for reference by the manufacturer; and these twenty museums are to be distributed in Great Britain and in India itself.

The volume now under notice is designed to form the key and explication and reference to the whole. Of the ability with which it has been put together, it would be hard to speak in terms of too great praise. The historical and actual survey of the varied costumes of India is written with great historical and ethnological and etymological knowledge, and in a genuine philosophical spirit, and always with strict reference to the object in view, never digressing or expanding into useless lore or dissertation. Illustrated by many photographs, which in certain copies are coloured by hand, we find all the typical dresses of every part of the body, of both sexes, of all the races of India, and with precise descriptions of the materials of which these are made, and occasional notices of the sources whence these come. Nor is the work confined to fabrics for dress only. It treats of sail-cloths, of cotton, carpets, felts, blankets, camel's hair cloth, lace, hand embroidery, &c. To the merely literary man or the ethnologist the work is full of interest; to the merchant and manufacturer it is full of importance. We can only hope that it may initiate a new state of things, and that in half a century hence it may be no longer true, as stated by Dr. Watson, that as regards textile fabrics at present India sells to us more than she buys from us.—Ed.

TO CORRESPONDENTS.

P.—We have known asbestus tried as packing for revolving retorts in chemical works, and there does not appear any reason why you could not use it for the stuffing boxes of your pump plunger.

Errata in last Part, pages 41 and 42.

CHATWOOD'S SAFE.

We are sorry to find that by an error which was not discovered before going to press last month, the two illustrations of Mr. Chatwood's safe in the article "How to make Safes Safe," were incorrectly referred to and described; and we therefore take the earliest opportunity of removing any false impressions which may have arisen from such oversight. Fig. 9 of the illustrations in the article in question ought to have been described as a vertical section of another of Mr. Chatwood's safes, built into masonry, and provided with his ingenious system of sliding claw bolts; whilst fig. 10 should have been referred to as a horizontal section of the same safe, which our readers will observe is a single and not a double leaved safe, as incorrectly stated.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

INSTITUTION OF NAVAL ARCHITECTS.

(*Continued from page* 61.)

That the course adopted in ocean mail steamers under Admiralty survey is desirable in all ocean steamers—viz., that there should be two hawse pipes fitted on each bow, and a second pair of riding bitts, so as not only to provide means for readily letting go and riding by a third anchor, but also to have a spare hawse-hole and bitt on each side, in the event of either of the working hawse-pipes or bitts breaking, or becoming unserviceable.

That on the beams of each compartment should be painted the whole tonnage of the vessel, and the capacity of the particular compartment in tons of 40 cubic feet, and that the dead weight and measurement tonnage in each such compartment should be shown on the ship's register before clearance.

That no dead weight should be permitted in either the fore or after sections of any passenger ship.

That all communications with the sea should be fully exposed to view, and be readily accessible to the engineers.

In the absence of any spar-deck the engine hatchway should have coamings or water-tight bulkheads round it, rising at least as high as the bulwarks.

Certains portions of the ship, as for example the screw alley, might be made accessible for repairs after they had been bilged, by forcing air into them, and thus expelling the water, and such portions should be made air-tight, and be in communication with force pumps with a view to this.

Spars and boats should be so disposed as to float off in the event of a wreck and form a substantial raft. Deck houses and other portions of the ship may also be so fitted as to be readily detached from the ship as rafts.

The council desire to place on record the following extract from the minutes of the proceedings of their first special meeting, on the subject of the safety of iron ships:—

"Mr. Charles Wigram (member of council): Assuming that the case of the *London* would come under consideration, offered to give the council all the information that his firm could afford on the subject.

"The council decided not to take up the case of the *London* as a subject of inquiry."

Mr. Wigram said he did not know whether it was proposed to move the adoption of the report. He did not wish to oppose its introduction, or to postpone any motion being made towards that object; but thought it desirable that it should be known to the members of the Institution that there were many of the professional members who did not coincide with the report, and particularly with some of the more important parts of it. He was sure of at least four, among the most eminent members of private builders, who had expressed their disagreement with many points in it. As it was proposed to take very important action, asking for a public commission of inquiry, to which Sir John Pakington had alluded, he thought it desirable it should be known they did not all coincide in opinion.

Mr. Scott Russell: I will merely make a single observation which will coincide with and carry out Mr. Wigram's view. The council felt that there might be great difference of opinion on those subjects—that it was not for them to legislate, or recommend legislation, and all they could do was to move that the subject be thoroughly inquired into by an independent body such as a Royal Commission. Before that Royal Commission I think I may assure Mr. Wigram that no body or part of the council of this Institution will ever make its appearance in a corporate capacity; but that every gentleman who is here will be called upon to give his opinion, and his opinion will rest entirely with that commission, if it be appointed, on its own merits. I merely say that the action which he deprecates has been most carefully and studiously avoided, and that there does not exist in this council, or in the mind of any of its members, the slightest intention to act in any manner in a corporate capacity beyond the report they have thought it their duty to make to you.

Mr. Grantham said that he quite agreed with the remarks which had fallen from Mr. Scott Russell, that there was no intention whatever on the part of the council of taking legislative action in the matter. Whatever might be the difference of opinion with regard to the different items of the report, there was one great feature presented by it, namely, that the minds of the naval architects, embracing the best informed men of the country, were fully alive to the importance of the question which had been started by the honourable president. The whole question had been discussed, and it was considered eminently the duty of the government to take it up at the point where the society must leave it. To expect that a document could be prepared, so that every member of a council should be unanimous as to its detail, would be expecting too much. The questions raised by Mr. Wigram were questions for private consideration. He (Mr. Grantham) was not clear upon all the points contained in the report, yet he gave his assent to the report as a

whole, as tending to an immense benefit to the shipping communication and the safety of life of the passengers and crews intrusted in those ships.

Mr. Reed said that as he had the honour of moving the original resolution, which had received the sanction of the Institution generally, he would just say a word before the subject dropped. He thought he need not say anything about the want of perfect unanimity in the council, as it was not to be expected that absolute unanimity could be secured, but the majority of the council fully concurred in the report which had been laid before the meeting.

The chairman then put it to the meeting that the report be received, and it was carried unanimously.

ROYAL INSTITUTION OF GREAT BRITAIN.

MILITARY BREECH-LOADING SMALL ARMS.* By Captain V. D. Majendie, R.A., Assistant Superintendent, Royal Laboratory.

Those who believe that breech-loading rifles formed no part of the equipment of the British army until the present or the past year—that they sprang directly out of the performances of the needle-gun in the late Bohemian campaign—will learn with surprise that not only had breech-loading been determined upon for our infantry nearly three years ago, and the actual pattern of arm that is now in the hands of a large proportion of our troops decided upon a full month before Königgratz was fought, but that two regiments of English cavalry were provided with a breech-loading carbine ten years ago. If we examine one of these Sharp's carbines, as they are called, we notice at once an objectionable feature, viz., that the ignition is effected by means of a percussion cap. Then again, the arm is provided with no

Sharp's Breech-loader.

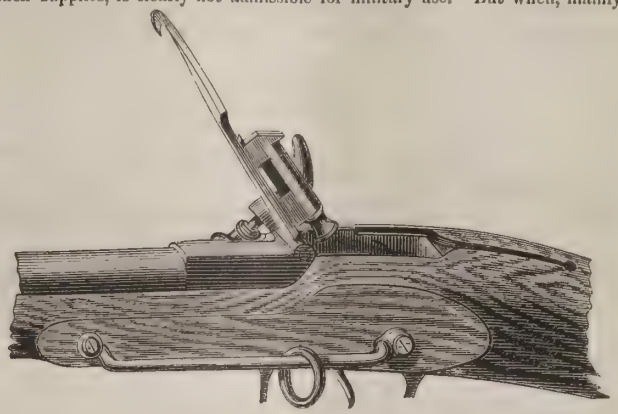
effective arrangement for checking the escape of gas. So great is this escape, that a handkerchief laid over the breech at the moment of firing will be burnt through and through; whereas with a close-fitting arm or cartridge the handkerchief should not be even soiled by the discharge. This defect is aggravated by the quantity of powder which in damp weather adheres outside the breech after loading. The back end of the cartridge is cut off thus, and the powder sprinkled about. From these two causes, the firer's face is generally flecked and burnt in firing; while the escape of gas tends also to foul and clog the breech action, which exposes large friction surfaces, and to render the arm more difficult to open as each round is fired. For these reasons—the retention of the percussion cap, the liability to an escape of gas, the flash occasioned also by the spilt powder, and the difficulties which often arise in loading—this system is extremely imperfect. And yet this system did undoubtedly reflect to some extent the state of feeling which prevailed in this country on the subject of military breech-loading arms a few years ago. For at that time this question was regarded exclusively as a cavalry question, and quick shooting was scarcely thought desirable for a cavalry soldier. . . . . .

Between 1857 and 1861 three other breech-loaders were introduced for experimental cavalry use. One of these, the Green's carbine, even in that easy age, never obtained a footing as a recognized service arm. But the Terry's carbine, which I have here, was introduced to some extent, and is not yet entirely obsolete; and the Westley Richards' carbine has found justly more favour. In 1861 this arm was definitively adopted. It is a great improvement on the others which I have named. It is an accurate arm; it fires six or seven rounds a minute with comparative ease and certainty; it spills no powder; it does not burn the firer's face or facings. Until the recent competition, Westley Richards' was accepted as the best type of military breech-loading arm known in this country, and, with its many objections, I would still pronounce it one of the most effective capping breech-loaders which has been produced.

But we have now to consider the subject in a broader light. It had been treated hitherto from one narrow point of view—as almost exclusively a cavalry question. We had considered only arms of which the percussion cap formed a material element, and a capping arm may be pronounced, with our present knowledge and for our present purpose, only half a breech-loader. Thus far, then, we may justly say that breech-loading had been cramped within contracted limits and misunderstood. But a couple of years or so ago the whole aspect of the case altered. As by a revelation we learned then what breech-loading really meant, and of what development the system was capable. It was a great epoch for breech-loading, its Hegira, it might be called, when it was discovered that the objections to cartridges containing within themselves the means of ignition had in reality no force. If we are to trace the stagnation which had hung over the question to a definite cause, we may confidently place our finger upon these objections.

* Paper read before the Royal Institution, Friday, March 1st, 1867.

When men said, and the ablest and most experienced military men did say, and our military authorities laid it down as a fundamental axiom, that cartridges containing their own ignition were not admissible for military use, what they meant was: 1st, That such cartridges were more liable than others to accidental explosion; and 2nd, That in the event of the explosion of one cartridge, the contents of the barrel were liable to be all exploded *en masse*, and so to communicate from barrel to barrel. If we grant these premises, the conclusion is just. Ammunition which is liable to explode in bulk, and thus not only to commit injury and dangerous havoc for the moment, but by its explosion to deprive the troops dependent upon it of their supplies, is clearly not admissible for military use. But when, mainly, I



Westley Richards' Breech-loader.

believe, by reason of the explosion of gunpowder at Erith two years and a half ago, men's minds were directed towards explosions generally, an experiment was made to determine the liability of small-arm cartridges—not breech-loading cartridges in this case, but the ordinary muzzle-loading Enfield rifle cartridges, ball and blank—to explode in bulk, and it was established not only that the explosion of a single cartridge in a barrel was not communicated to the rest, but that the explosion of a number of cartridges, or even of ¼ lb. of loose powder, although it might burst open and destroy the barrel, would not occasion a general explosion. Although the bearing of this fact upon the question of breech-loading was not immediately perceived, it furnished the opening through which presently a flood of strong new light rushed in upon the subject.

This effect proceeds from the same cause as that which operates in rendering the well-known Gale gunpowder inexplosive. Mr. Gale inclosed each grain of his powder in an incombustible envelope of finely-powdered glass or bone-dust. In a barrel of cartridges we have not each grain enveloped, but a number of grains, so many as compose one charge, in a non-combustible case. I have tried over and over again to explode a barrel of the service breech-loading cartridges without success. I have several times fired one cartridge in a barrel without igniting the remainder. I have fired ten cartridges at once, and no more have fired. I have gone further, and placed the barrel inside an iron cylinder, tightly screwed down, and have exploded ¼ lb. of powder in the midst of the 700 cartridges which it contained; and although the screws were broken and the lid of the cylinder was blown off with violence, and some of the cartridges were strangely distorted, none of the cartridges were ignited. Experiments not less exhaustive have established also the non-liability of these cartridges to separate accidental ignition, by concussion or otherwise. In this way we dispose of the objections which have been entertained against cartridges containing their own ignition, and establish their admissibility for military service. . .

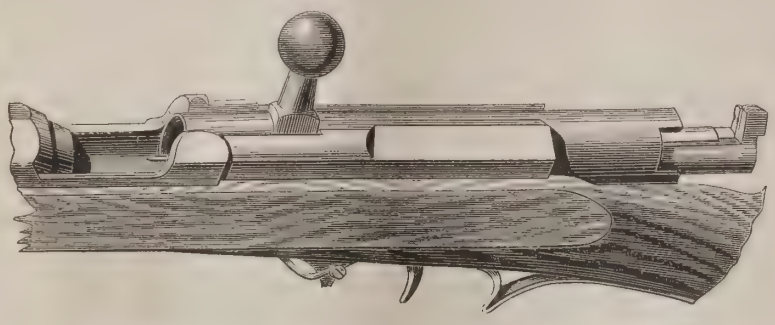
Between 1859 and 1864 no less than twenty-six different plans of breech-loading were proposed. For sporting purposes, too, breech-loading guns had found their way into very general use, and in America they were being largely applied experimentally for military service. But always this shadow hung over the question, that cartridges containing their own ignition were not generally considered admissible for military use. And as breech-loaders not adapted for such ammunition presented comparatively few advantages except for cavalry, for whom, as I have explained, quick firing was not specially desired, and as the development of the system was thus stunted, the question was in fact argued in a circle, and the subject remained up to this period practically at a stand-still.

But when once this fatal restriction and limitation were removed, we began at once to make real progress in the matter. It was no longer a question merely of an arm which presented certain minor facilities of manipulation—of an arm somewhat easier to load on horseback; but it became obviously a question of an arm which would multiply the fire of an army three or fourfold, which, properly considered, would place, as it were, three or four rifles in each soldier's hands.

In the course of the Dano-German war the value of the famous needle-gun, or rather of the system of which the needle-gun was an indifferent exponent, became in the eyes of observant men fully established. So obvious was the teaching of this campaign, that our then secretary of state for war, Lord De Grey, appointed forthwith a committee, with General Russell as president, to "report upon the advisability of arming the infantry, either in whole or in part, with breech-loaders." After four meetings this committee reported, abstractedly and without reference to any particular system, that it would be desirable to arm the whole of the infantry with breech-loading rifles; and on the day on which this report was drawn up, the 11th July, 1864, the death warrant of muzzle-loading rifles for the use of the British soldiers may be regarded as having been signed.

The next question to be considered was, how to give effect to the recommendations of the committee. This question admitted of consideration in two ways: either by itself with a view to ascertain the speediest and cheapest mode of placing a breech-loader in the hands of the troops, or in combination with other questions connected with rifles, such as the best size of the bore and the best mode of igniting the

cartridge, and with a view to determine what would be, in all respects, the most perfect arm for the use of the infantry. The first mode of dealing with the question would have the advantage of celerity, the second of completeness. But why not have combined the two, by arming the British army immediately with the needle-gun? Here was a complete system—a good system, perhaps some will say, ready made to our hand; a system, too, which had had the advantage of being tried on actual service, and which, if economical considerations were to have any weight, had been adopted by a nation very much less able to bear heavy expenditure than ourselves. I have here a needle-gun, which will, I think, answer this question for itself. Take the gun as it stands, and tell me—those of you at least, and I doubt not there are many who are accustomed to handle the beautiful weapons which



Prussian Needle-gun (breech open).

England puts into the hands of her soldiers and her volunteers and her sportsmen—tell me if this clumsy rifle is one which you would have cared to see issued to our troops. But why not, you will say, improve the workmanship of the piece; make it lighter, balance it better, alter its bore if need be, or its mode of rifling, improve its mechanism, and when you have suited it to the more advanced requirements of this country, adopt it?

Need I point out to you that such a measure would have disposed of the first argument for the adoption of the arm. We are no longer in this case adopting a system ready made to our hands. We are, in fact, creating one. We are adopting a breech mechanism, merely one element of a system, nothing more. And but little knowledge of the subject was needed to instruct us as to the extremely defective nature or principle of this breech mechanism. If I handle the needle-gun you will see that it is comparatively slow. It is clumsy and imperfect in other ways. The needle with which the cartridge is ignited is very liable to become bent or injured. I shall be reminded that these needles are easily replaced, that each Prussian soldier carries two or three. But this injury and replacing of a needle temporarily disables the arm, and constitutes, it must be admitted, an objection. Then again, the gas-check is not permanently reliable. The whole escape is thrown upon the arm at the junction of the breech, none upon the cartridge; and even if we set out with a tight fit, the fit will become less and less close, and in time, if the arm be not carefully looked to and repaired, an inconvenient escape of gas will occur—an escape which sometimes induces the Prussian soldier to deliver his fire by preference from the hip. Of the ammunition it will be sufficient to say that it is rude, and for technical reasons ill adapted for the requirements of military service. The egg-shaped bullet is imbedded in a small papier-maché wad, which serves the double purpose of rifling the bullet, which never touches the grooves, and of containing the fulminate, which the needle, penetrating the powder and the thin paper envelope which incloses the whole, has to pierce. In short, the needle-gun, however superior even to a *good* muzzle-loader, was not such an arm as we should have been justified in adopting, except in an emergency more pressing than that which now presented itself.

Of the other systems of which we had any experience, and which you have seen, there was none which seemed calculated to satisfy our requirements, and their adoption was accordingly not entertained.

Under these circumstances, having no complete system to begin upon, we determined to take so much of a known and reliable system as we approved, and apply it. By this course we should get, as it were, a lift upon our road, and start somewhat in advance of the point from which we must set out, if we elected to consider the question *ab ovo*. Therefore, and without prejudicing the ultimate and more leisurely investigation which the question as a whole demanded, we resolved to take so much of the existing arm—the Enfield rifle—as seemed to us good, and to revolutionize that part of it which we deemed bad. We determined, in short, to convert our Enfield rifles into breech-loaders. In speaking of the Enfield rifle as a good arm, I am anxious not to be misunderstood. It is an arm doubtless with many defects, if we judge it by the rigid standard of more modern requirements. A steel barrel, for example, would probably be preferable to a wrought-iron barrel; the Enfield twist is undoubtedly too slow for extreme accuracy; and the calibre may be considered as unnecessarily large. The refinements and progress of gun-making have left the Enfield rifle to a certain extent behindhand, just as the refinements and progress of breech-loaders have left the needle-gun behind; and yet in the main it is an excellent weapon for military use, and I know no power whose soldiers possess a muzzle-loading rifle which can compare with it. We do not, recollect, require a match-rifle for military purposes. Except on a few rare occasions, such an arm would have no special value. It was Lord Palmerston, I think, who pointed out that what the soldier is required to do is, not to hit a particular button upon his enemy's coat, but generally to drive home an effective fire into an opposing body of infantry or cavalry. . . . . Instructed, then, by the sober teaching of actual warfare, we were justified, I think, in assuming that if to this Enfield rifle, without subtracting from its accuracy and other qualities, we could apply an effective breech-loading arrangement, we should be at once relieved of all pressing anxiety, and in a position to select leisurely a new and superior breech-loader for future manufacture. Moreover, there were more than half-a-million of these muskets available for conversion; and the step which was proposed had the secondary, but by no means inconsiderable, advantage of economy. It had other subordinate advantages, such as the experience in breech-loading equipment to be derived in the course of the inquiry, and which might stand us in good stead when the more complete and difficult question should come before us, and finally the avoidance of the danger of hurrying without due consideration into the adoption of a possibly unsatisfactory arm.

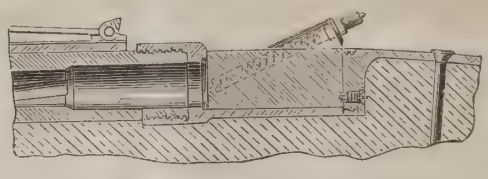
In August, 1864, an advertisement was issued, inviting gunmakers and others to submit propositions for the conversion of the Enfield rifle. From the fifty systems which were sent in in reply to this advertisement, those which were obviously unsuitable were eliminated, and eight systems were selected for trial, of which five only, for reasons which it is unnecessary for me to detail, ultimately came to the post. Of these, four were capping arms, one only a non-capping arm. The selection for trial of these capping arms indicates that we were not then quite as advanced or decided upon this point as we are now, and had not yet absolutely learned to regard non-capping as a *sine qua non*. So Westley Richards', Mont Storm's, Wilson's, and Green's converted Enfield rifles entered the lists against the solitary representative of the non-capping system—the Snider rifle.

Westley Richards' converted Enfield was substantially the same in respect to its breech mechanism as the cavalry carbine which I have shown you, with the addition of a small hook at the end of the plunger for withdrawing the wad after firing.

In Wilson's arm the breech of the original rifle is removed, and the barrel prolonged for some inches in the form of an open slot. The cartridge is inserted here and pushed forward into the barrel, and is followed by a sliding plunger, which is fixed after loading by a stout bolt which passes through stock and plunger. There is an india-rubber ring to diminish the escape of gas.

The Green rifle resembled the Wilson, except in the manner of securing the plunger, which is furnished with a small knob, and is turned round after loading a quarter circle, and so locked.

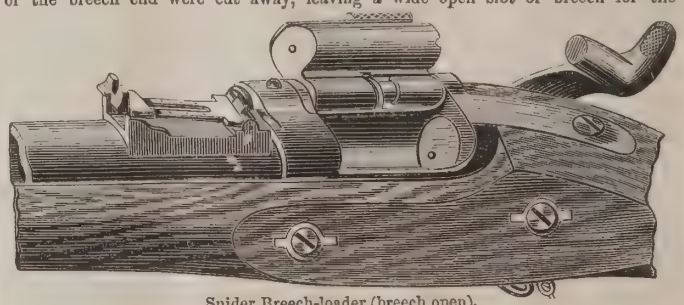
The Montgomery Storm or Mont-Storm arm is one of that class of breech-loaders known as "chamber-loaders." A chamber-loader is in fact a sort of muzzle-loader cut short, or so arranged that the arm can be conveniently loaded by hand, without the assistance of a ramrod. The charge is deposited in a short chamber, instead of being rammed all the way down a long barrel; and the chamber is then replaced in the position for firing in the prolongation of the barrel. Of breech-loaders on this plan there are many modifications. In this arm the hinge is in front of the chamber; in many rifles (the Swedish rifle, for example) it is behind, and that would



Snider Breech-loader (longitudinal section).

probably be the most primitive form of chamber-loading. Colt and Deane and Adam's revolvers are examples of chamber-loading arms having several chambers. In these arms the chambers are not hinged but revolve, and are brought in succession into prolongation of the barrel. I have several other examples of chamber-loading arms here, to which I would invite your attention after this discourse. The chamber of the Storm rifle can be turned completely over the breech, and loaded; or it may be swivelled at right angles to the barrel for loading with loose powder. When the chamber is returned it is secured by a bolt worked by the lock, and an escape is prevented by an expanding ring or thimble on the pan of the chamber.

In the first arms made on the Snider system, about two inches of the upper side of the breech end were cut away, leaving a wide open slot or breech for the



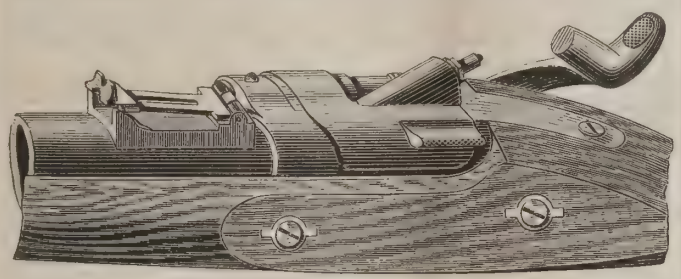
Snider Breech-loader (breech open).

admission of the cartridge. When the cartridge had been pushed forward into a taper chamber formed by enlarging what was now the hind part of the barrel, the slot was closed by a lump of steel, hinged on the right side of the barrel, and forming a false breech. It was afterwards found more convenient to remove the back part of the barrel bodily, and to replace it with a "shoe," in which the whole of the breech arrangement was comprised; other modifications followed, until we got at last the more perfect arm which I hold in my hand. The breech-block, you will see, hinges upon this pin and works thus. It is kept in its place by a small spring stud; and the fit of the block tends also to hold it. In order to meet a possible objection that this arrangement is liable to wear and get out of order, I have brought a "shoe" which has never even been hardened, but which has fired at least 30,000 rounds, and still remains, as you will see if you care to inspect it presently, perfectly serviceable.

The ignition is effected by means of a small piston or striker, which passes through the breech-block, and which, when in repose, is flush with the face of the block. A blow of the hammer causes it to dart forward about a tenth of an inch into the cap, which is fixed, as I shall presently more particularly explain, in the base of the cartridge. The piston is returned by a spiral spring. To withdraw the empty cartridge case, a claw or extractor forms part of the breech-block. When I withdraw the block, the empty cartridge is necessarily drawn with it, and by canting the rifle sideways the case is thrown out. The extractor is returned by another spiral spring. With regard to this spring, to which objection has been taken, I would point out that it is negative, not positive, in its action. The spring in the needle-gun is positive, and the action depends upon it. In this gun, the spring is an auxiliary merely, not an essential. We can do without the spring. It is better to have it; but if we have it not, if it becomes damaged or inert, the extractor can be pushed back by hand. And lastly, the spring in this case is never repressed to a greater extent than about one-tenth of an inch.

It has been stated lately that the Snider system was not really invented by Mr. Snider at all, but by M. François Eugene Schneider; or to go further back, by Mr. John Poad Drake, a Cornishman. But if we are really to trace the system to its source, we must go back to a time which places the invention quite beyond the reach of living men. I have thus far not ventured on the archæology of breech-loading; but if you will permit me, I will make one dive into antiquity for the purpose of bringing under your notice two breech-loading fire-arms of the reign of Henry VIII., on the Snider system! By the kindness of Admiral Caffin, these interesting arms have been lent to me from the museum of the Tower, for the purpose of exhibition this evening.

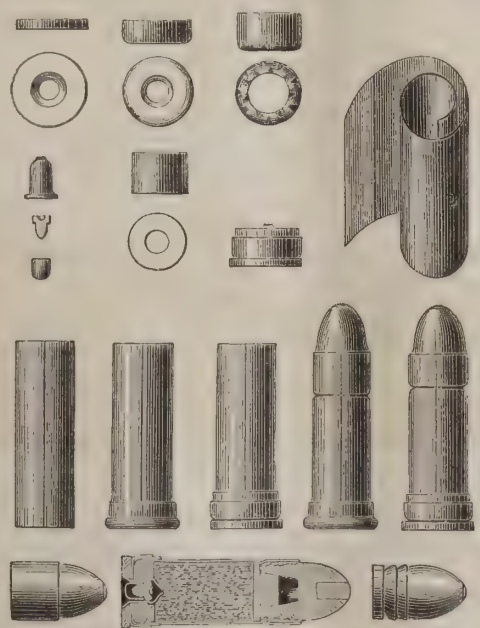
In the course of the competition the Snider gun proved about 50 per cent. quicker than its rivals; it was stronger too; it was simple, and apparently durable, the breech arrangement being well adapted to sustain the shock of any number of



Snider Breech loader (breech closed and full cock).

discharges, from the fact of those shocks being sensible only in a direction at right angles to that in which a force must be exerted to open the breech; and lastly—I should perhaps have placed this advantage first, not last—it was adapted for a cartridge containing its own ignition.

Among the capping arms, the Mont-Storm rifle was ranked first, and was recommended for experimental application to a certain number of rifles. The system failed subsequently at proof, and the recommendation was cancelled. It failed partly on account of the unsuitability of the skin cartridge which formed part of the system; and this reminds me of another objection to which all capping arms are



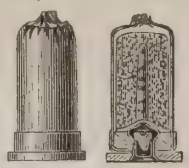
The Boxer Cartridge for Snider Gun, with Details of Construction.

open. Such arms need a cartridge so thin, that the fire from the cap shall pierce it, and at the same time the cartridge must be so entirely consumed or carried out by the discharge, as to leave no residue to endanger or interfere with loading. These requirements make it difficult to satisfy another not less important point in a military cartridge, viz.: that it shall be strong enough to stand the knocking about to which it will inevitably be exposed in transport and on service. Moreover, a thin cartridge is evidently less well adapted than a stout one to resist the effects of an accidental adjacent explosion. But the Mont-Storm rifle failed also in the arm itself. Under proof charges, the hinge and small bolt by which the chamber is locked were broken.

The Snider rifle, while satisfying many requirements, failed in one important respect. It was so inaccurate as to be quite unsuitable for adoption as it stood. . .

As the fault could not lie in the barrel, which the accuracy obtained under the other systems showed could be converted without detriment in this respect, it was due obviously to the ammunition which Mr. Snider had submitted. At this point then, the question of providing more suitable ammunition for the arm was referred to Colonel Boxer, by whom, after a year's experiments, the present service ammunition was designed. Discarding the papier-maché case submitted by Mr. Snider, the objections to which, especially in damp weather, are well known, Colonel Boxer made the case of his cartridge of very thin sheet brass, ·003° thick. The cartridge has a little over two turns of this brass.

Five important advantages result from the employment of this case:—1st, Being uncoiled slightly by the explosion, instead of depending upon the mere stretch of the material, the case can be used in a chamber considerably larger than itself, with little danger of breakage and consequent escape of gas. 2nd, It is not liable to swell with damp, and so to interfere either with loading or withdrawal. 3rd, The difference between the size of the case and of the chamber is so considerable, as to permit of loading even when the case has been considerably enlarged or disfigured by rough usage. Nor under these circumstances again is there any danger of leakage or escape. 4th, Such a cartridge may be made, like the present service cartridges, practically waterproof. 5th, The reaction, or tendency of the case to recoil, which arises after the pressure of gas is removed, tends to render a case of this sort easier of extraction than any other. All of these advantages hold good against a papier-maché case; many of them hold good also against a case of simple copper or other metal. . . . .



Boxer Blank Cartridge.

The last point to be noticed in the ammunition for the Snider rifle is the bullet. On this the accuracy of fire of the arm depends. The bullet is not made, as in the majority of breech-loading arms, slightly larger than the bore, but depends for its action upon the system of expansion which Colonel Minié was, I believe, the first practically to adopt, viz., a hollow on the base, together with a plug, by which the original Minié iron cap has been superseded. This plug, which is now made of

Pin Cartridge and Prussian Needle-gun Cartridge.

baked clay, plays the double part of expanding and supporting agent. The expansion of the bullet would be effected, it is true, to a great extent by the simple action of the powder gas upon the sides of the hollow. But a plug makes that expansion more instantaneous and more uniform; and above all it supports the sides of the bullet after expansion. Thus with a plug the passage of the gas is prevented and fouling diminished, in the first place; and in the second, even when fouling has been established, its effect upon the accuracy of a plugged bullet, whose sides do not collapse when they come into contact with the obstructing deposit, will be much less than upon an expanded bullet which has no plug.

Another important feature of the bullet is the wood plug in the head. By this plug we obtain three advantages: greater length, and so a broader bearing and lubricating surface; secondly, the centre of gravity is more favourably adjusted with reference to the requirements of the projectile and the slow twist of the piece; thirdly, the weight is disposed, as in the fly-wheel, away from the axis of rotation. . . . .

Round the bullet are disposed grooves or cannelures, which serve to carry the bees' wax lubricant, by which means a layer of wax is always interposed between the lead of the bullet and the sides of the bore; and fouling is so completely got rid of that one of the best targets ever made with this arm was made after 1000 rounds had been fired from it without cleaning. This point is one of extreme importance, for the accuracy of a military arm is to be measured by its average accuracy during a long-sustained fire, and not by its performances when perfectly clean. The measure of efficiency of a military arm in this, as in other respects, is to be obtained by taking the arm, not at its best, but at its worst. In other respects the ammunition satisfied the tests which were imposed. It stood an extraordinary amount of rough usage. It was waterproof to an extent which enabled it to be kept for a whole week in wet sawdust without injury; it was easy of extraction, not liable to escape or explosion; and its expense is very little greater than that of a paper cartridge, even if we take its first cost merely, and immeasurably less if we spread the cost over the periods during which the two ammunitions would respectively remain serviceable—if indeed, the paper cartridge could ever be considered serviceable. The extreme rapidity of fire in the arm is fifteen shots per minute. Of this ammunition about 8,000,000 rounds have been issued up to the end of last week, and of the arms in round numbers 100,000. To deal with the false and exaggerated reports which have been circulated respecting the "failure" of the Snider system is a task which I cannot undertake, except in a general way. I can only say that in essence and in substance these reports are false. There have been difficulties of detail, it is true, but fewer and less serious difficulties, I believe, than have ever attended the introduction of any new system of guns or small arms; and whereas the general tenour of the misstatements to which I refer has been that the system has failed, the general tenour of the reports of the troops, in Canada, at Hythe, and at Aldershot, to whom the arms have been issued, has been that the system has proved, on the whole, and specially with reference to the cartridge and the breech action, admirably successful. It may tend, perhaps, to

restore confidence, also, if I state that the per centage of failures out of a total of about 50,000 rounds of ammunition, which, in the course of my duty, it has fallen to my lot to fire since the arms were introduced, has amounted to little over one failure in every 300 cartridges, including every defect, however slight—every miss upon the target at 500 yards, every misfire, every cartridge which has split or failed from any cause. And out of more than 20,000 rounds fired by the Ordnance Select Committee, the percentage of failure has been, I believe, even less. . . . .

Breech-loaders may be divided in two great classes:*—(*a*) breech-loaders, in the ordinary acceptation of the term; and (*b*) repeaters.

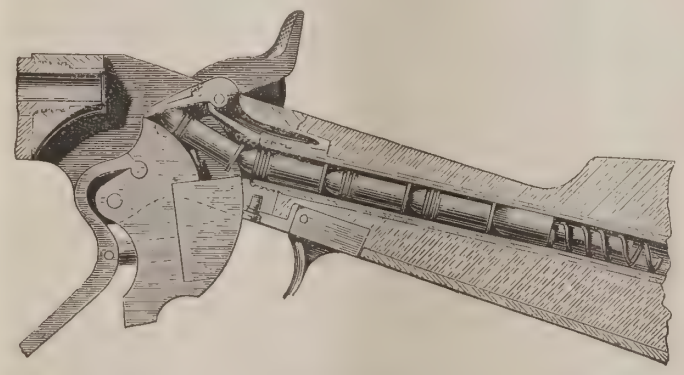
The first class may be further subdivided into (1) chamber-loaders, and (2) breech-loaders proper. Of *Chamber-loaders* I have already shown you two examples, the Mont Storm and the Hägstrom. I have here several others, such as a Spanish arm (Garcia's), Bergstrom's, and another Norwegian system; Leetch's, Mackenzie and Wentworth's, &c.

The more conspicuous defects of this class of arm would seem to be their liability to injury by the explosion, which generally acts directly upon the breech mechanism. On the other hand, they are generally perfectly free from escape of gas, except sometimes at the junction of chamber and barrel. In Sweden and Norway chamber-loaders find more favour than in this country.

Breech-loaders proper include more numerous types of arms. The Snider rifle is an arm of this class; so is the Westley Richards, the Terry, the Sharp, the Green, the needle-gun, all of which you have seen. I have here several others, some good, some bad, some celebrated in their way, and some which exhibit the imperfections of which the system is capable. The Amsler-Millbank system (adopted by the Swiss government for conversion), Joslyn's, Bayliss', Restell's, Beard's, Bruton's, Prince's, the Starr carbine (now in use in Canada), Fosbery's, Laidley's (adopted in Russia), are all examples of breech-loaders proper. In these arms, as a rule, very much more work is thrown upon the cartridge. Where, as in the needle-gun and the Sharp carbine, the escape is sustained by the gun, and not by the cartridge, the system will generally be open to objection on the score of excessive escape of gas. With secure ammunition, this defect may be entirely got rid of; and to me it seems sounder in principle and more reliable in practice to throw the burden of the escape upon the cartridge, which only has to sustain it once, than upon the arm, which must sustain it many hundreds or thousands of times.

(*b*) *Repeaters* may be subdivided into (1) revolvers, and (2) magazine arms. Of *Revolvers* the best examples are furnished by revolving pistols, of which, by the addition of a long stock and barrel, rifles have sometimes been made. I have here also a revolving carbine, by a Colonel Porter. The system is open to many objections, among which, except for pistols, the weight of the several chambers is conspicuous.

Of *Magazine arms* there are two important varieties:—The simple repeater, such as Henry's, in which the cartridges are constantly drawn from a magazine under the barrel, which must be replenished from time to time as it becomes exhausted; and secondly, an arm which, like the Spencer and Lamson rifles, can be used as repeaters or simple breech-loaders at will. In these arms I can, if I wish, shut off the magazine, and load them as ordinary breech-loaders. This plan presents several important advantages over the ordinary repeater, which entails distinct intervals of inefficiency while the magazine is being replenished, and which directly tempts the soldier to indulge in an excessive rapidity of fire while his magazine supply lasts. But in the improved repeaters these objections are obviated. I have here, for example, the Lamson rifle, with its magazine full. I need not, however, call upon the magazine, but I may load as if the arm were an ordinary



Spencer's Repeater.

breech-loader. Then when pressed I can, so to speak, turn on the tap of the magazine, and pour forth such a fire as no simple breech-loader can deliver. When my magazine is exhausted, I am not, as with an ordinary repeater, temporarily disabled; for I can fall back upon the simple breech-loading action, until an opportunity presents itself for replenishing the magazine against another emergency. So with the Spencer rifle, in which, as you will see from this diagram, the magazine is situated in the stock.

The direction in which repeaters generally err is in complexity of construction; but if this defect can be overcome, a magazine rifle would present immense advantages over the simple breech-loader, not merely for those services, such as the navy, the cavalry, and artillery, in which an intensely rapid fire is generally required for a few decisive moments, but for the universal equipment of troops. It is in arms of this class that breech-loading tends towards its highest development; and to this principle of action, I believe, we must look for the complete and ultimate solution of the breech-loading question. . . . .

The advantages which breech-loading presents in a military rifle are—

First, *Rapidity of Fire.* We give each soldier, so to speak, and as I have before expressed it, three or four rifles, with the inconveniences only of one. At close quarters no troops, however brave, devoted, or disciplined, could stand with muzzle-loaders against a corresponding force armed with breech-loaders. It amounts to being opposed to a force whose numbers are practically multiplied by the figure which expresses the ratio of rapidity of fire of the breech-loaders to the muzzle-loaders. We must not press this argument too far. It will hold generally when the fighting is quick and close and decisive, and when the conditions of the contest on both sides are the same. But breech-loaders will not do everything; and we must avoid the error of supposing that they did everything in the Danish or Bohemian campaigns. The needle-gun was but the embodiment of that spirit of *geist* and progress which animated the Prussian army and its leaders, which dictated the execution of their rapid movements, and which was the soul and essence of their superior organization. Especially must we avoid the too close application of mere abstract reasoning when the element of artillery fire comes into play. Eleven years ago an experiment was made at Hythe with life-size dummy figures of men and horses, which went to prove conclusively that artillery would be beaten off the field by infantry armed with rifles. It was then proved that a detachment coming into action would be annihilated in three minutes by thirty file of riflemen. But two important considerations were overlooked: that in actual warfare infantry would scarcely deliver so effective a fire as then served to plant at 800 yards' range thirty-four shots in a single gun detachment; just as two men standing opposite one another at twenty paces to fight a duel often fail to hit one another, while at a very much greater distance they can each easily break a bottle's neck in a pistol gallery. And, secondly, the necessity for artillery coming within this range at all was not established; so that the reasoning which was based upon these premises fell in practice to the ground: and notwithstanding improved musketry instruction and improvements in the arms, the use and importance of artillery have in no wise diminished since the introduction of the rifle for general service; so those also would be mistaken who might argue from this diagram that if so much could be done with muzzle-loading rifles, firing as they did on this occasion one round per minute only, breech-loaders firing seven or right rounds per minute would produce a corresponding effect, and that the predominance of artillery fire in an action must henceforth cease to exist. But within reasonable limits, the effects of breech-loaders, as opposed to muzzle-loaders, can hardly be over-estimated. It must be remembered, too, that there is always attendant upon the employment of a more effective arm a moral as well as a physical effect. As Marshal Marmont said, a battle is decided after all not by the number of men killed, but by the number frightened.

By a converse application of this argument, we reach the second great advantage of breech-loading—*increased confidence*, a point upon which I need not dwell, but of which all military men will recognize the importance.

Thirdly, we obtain greater *facility in loading.* On horseback, breech-loading, even of an imperfect kind, is vastly superior mechanically to muzzle-loading. For the infantry man, if we reflect a moment, the advantages will appear quite as great. Whatever the soldier's position, whether lying behind some sheltering mound, cramped in a rifle pit, working in close squares, with his bayonet presented to resist cavalry, or running forward as a skirmisher, he could load a breech-loader as he could never load a muzzle-loader—without exposing himself, without changing his position, without inconvenience or loss of time or effect.

We have, in the fourth place, *improved shooting.* The arm is always loaded in a position which favours the subsequent delivery of a low and effective fire. The eye is never removed from the object; and no part of the powder can be spilt, no part can be lodged in the grooves of the rifle; while the increased confidence of which I have spoken tends to steady men's arms and improve their aim. It has been objected that the rapid firing of the breech-loader will tend to tire and unsteady men's arms, but surely this objection, if it has any force, may be met by the consideration that the operation of loading a breech-loader is very much less fatiguing.

Fifthly, *the possibility of overloading is avoided.* This, in the hurry and excitement of action, is no uncommon accident. A man loads, and, as he thinks, fires. His cap misses fire, or he even neglects to cap at all. But he does not at once recognize it. He rams down another charge: perhaps another, &c., &c. After one of the American battles several arms were picked up loaded with two charges, others with three, some with four, and a few even with eight!

Among the minor advantages of breech-loaders, I may name the completeness and compactness of the ammunition; the facilities for cleaning and inspecting the arms; the ease with which the drill may be acquired; the diminished danger in loading; and the possibility of the arm being rendered inefficient by the loss of a ramrod.

It has been said that breech-loaders will entail an excessive expenditure of ammunition. But, in the first place, we have no grounds for supposing that the ammunition expended will be *wasted:* and a similar argument would have held against the supercession of the old flint-lock by the percussion cap. If the fire be delivered at such ranges that the shots tell, it merely amounts to this, that the work is done with the new system so much quicker and more effectually than with the old; and experience teaches us that the requisite supply can be kept up without difficulty, even in a long hot general action, and that this objection has been much overrated. It is stated, indeed, that the greater coolness and confidence of the men tends rather to a less expenditure; and the number of rounds fired by any individual Prussian soldier in the late campaign, if figures are to be relied upon, would seem to favour this view. The supply of ammunition, whatever its expenditure, is, however, only a question of organization; its *efficient* expenditure is a matter of instruction.

* A number of characteristic specimens of British and foreign breech-loaders were exhibited. Their special peculiarities were referred to in the discourse, and discussed in the library afterwards.

BREECH-LOADERS

Already Adopted or in Contemplation by the Different Military Powers.

	System of Conversion.	New Arms.	Remarks.
England,.....	Snider,.....	Not determined.	
France,...	Nil.	Chassepot.	Other systems still undergoing trial.
Austria,.....	Wanzel,....	2000 Remington's ordered for trial.	The new arm not finally decided.
Prussia,.....	Nil.	Needle-gun.	
Spain,.....	?	?	
Portugal, ...	?	Westley Richards.	
Sweden,.....	Nil.	Hägstrom.	
Norway,.....	?	?	
Belgium,.....	Snider,.....	Not determined.	Several arms under trial.
Switzerland,...	Amsler-Millbank, ...	Winchester.	
Turkey,.....	?	Lamson.	Uncertain.
Egypt,.	Snider,.....	?	Uncertain.
Russia,.....	Terry,...	Laidley.	
United States,	?	Berdan, Spencer.	
Canada,.....	?	Peabody, Starr, Spencer.	
Italy,.....	?	Westley Richards.	Large numbers ordered

MONTHLY NOTES.

The Eight New Gun Vessels.—The following firms have been fixed upon by the Admiralty to build the eight new gun vessels, for which the engines have already been contracted, viz.:—Messrs. Randolph & Elder, of Glasgow; Mr. Laurie, of Glasgow; Messrs. Thomson & Co., of Port-Glasgow; Messrs. J. Reid & Co., of Port-Glasgow; Messrs. Harland & Wolff, of Belfast; Mr. Pearse, of Stockton-on-Tees; the London Engineering Company, of the Isle of Dogs; and Messrs. Laird Brothers, of Birkenhead.

Tenacity of Steel Rails.—At the Chalk Farm Station of the London and North-Western Railway a Bessemer steel rail is now to be seen still in use, and in good order, which has outlasted twenty-five iron rails successively placed next to it on the same line. Judging by this example, the steel rails are at least twenty-five times as durable as iron ones. Steel rails are very tough; as some experiments made within the last few days at the works of Messrs. John Brown and Co., and Messrs. Cammell and Co., of Sheffield, conclusively illustrate. These experiments were made chiefly for the satisfaction of the Hon. W. J. MacAlpine, formerly engineer of the state of New York, and much connected with railways in America, who contemplates the more extended introduction of steel rails into that country. The result was to show the great toughness and powers of endurance of the steel rails. In one of the experiments a ram of a ton weight was suffered to fall upon a rail of 68 lbs. to the yard, supported on iron blocks 3 feet apart in the clear, from a height of 20 feet, and the only effect was to bend the rail. The rail was then turned upside down and the blow was repeated, when the rail was bent straight, but without any cracking being visible. Finally, the rail was exposed to the test of a ton ram falling through 30 feet, when the rail was very much bent and twisted, but not a crack was visible. By the mode of manufacture now adopted perfect uniformity in the composition of every rail is insured.

Mont Cenis Tunnel.—According to the official report received by the minister of Public Works at Florence, it appears that the boring works of the great tunnel of the Alps at Mont Cenis, on the north side of Modane, had passed, on the 8th of last March, the bed of quartz which had been met with in June, 1865, and they had passed through a schistose limestone, mixed, and were now in pure limestone. The length of quartz passed is 381 metres, approaching in a surprising degree to the 348 metres estimated at the beginning according to the external appearances and the inclination of the beds. From the 8th of March the nature of the rocks has been always the same, and the advancement in the small tunnel, which in the quartz bed never exceeded on the average 15 metres a month, has almost entirely resumed its original progress. It is satisfactory to publish the results obtained in the two fortnights of March, results which show that the work of boring has gone on with regular development on both sides. Progress during the first fortnight in March in the small tunnel was—south side, 34·55 metres; north side, 19·37 metres. During the second fortnight in March—south side, 41·25 metres; north side, 38·17 metres. Total work in the month, 133·34 metres. Total length of the bored part—south side, 4119 metres; north side, 2528·25 metres; total, 6647·25 metres. Total length of tunnel, 12,220 metres. Portions bored, 6647·25 metres; remaining to bore, 5772·65 metres.—*Journal Society of Arts.*

London Association of Foremen Engineers.—The ordinary monthly meeting of this society took place on Saturday the 4th ult., at the London Coffee-house, Ludgate Hill. Mr. Joseph Newton, president, filled the chair, and the spacious and well appointed assembly room henceforth to be devoted to the business of the association was quite full. When the routine duties of the sitting had been performed, the chairman proceeded to deliver a lengthy and interesting address. He alluded in the first instance to the steadily progressive influence of the institution, and congratulated his fellow members on the fact that they had now secured for themselves a local habitation in all ways suitable for their purposes. As in the past the society had been completely successful in realizing its objects, so it would be in the future if the proper amount of energy and interest was exhibited by each member. It was not for them to rest and be thankful, but to rest and then go forward with increased vigour. They now numbered 150 members, but he (the chairman) saw no reason for supposing that that number would not soon be doubled. They had, it was true, among them representatives of nearly every large engineering establishment in and near London. These were mainly foremen, but their ranks were open to mechanical draughtsmen also, and he hoped eventually to see a large accession of members from that eminently useful and highly intelligent body. The chairman adverted to the fact that the honorary members of the society were almost all gentlemen of great eminence, and there was among them a very large proportion of employers. It was to be hoped that these and other scientific friends would be induced to attend their future meetings and share in their proceedings. Other points were touched upon and urged with considerable emphasis, and all had a bearing upon the future prospects and welfare of the association. Finally, Mr. Newton declared the new meeting place open for the despatch of business. The first question introduced and discussed had reference to a collective scheme of life assurance, which the chairman had suggested, and which had been favourably entertained by the great mass of the members. Mr. Fothergill, on behalf of the Royal Insurance Company, attended, and lucidly explained the arrangements which that office was ready to make for insuring the payment of £100 on the death of any and every associated foreman. The terms appeared to be very advantageous for the society; but eventually a committee was appointed to inquire into and report upon the whole subject. Mr. J. Irvine next read a very elaborate and exhaustive paper on "Indicating the Power of Steam Engines." He treated the subject in a practical manner, and illustrated it by many diagrams. It is difficult to summarize the paper, which occupied nearly an hour in reading; but we strongly recommend that it be printed *in extenso* in the Transactions of the society. The discussion, owing to the lateness of the hour, was brief, and a further consideration of the subject was adjourned till the June meeting.

Monmouthshire Steam Coals.—About three years ago, when the celebrated trials took place as to the relative merits of Welsh and north country coals, certain regulations were laid down by the Admiralty authorities which practically excluded Monmouthshire steam coal proprietors from competing for navy contracts; and, as a natural result, the price of the coal in the open market was also affected. It is well known that coal not on the government list is always put down as a relatively inferior article, and hence it is not surprising that the colliery proprietors of Monmouthshire at once took steps to obtain a reversal of the regulations referred to, and which in reality amounted to a virtual denial of the right of Monmouthshire steam coals to be on the government list. A memorial was got up in reference to the matter, which stated that the steam coals of Monmouthshire were known as bituminous, and for economic value and evaporative power were fully equal to north country coals. In June and July, 1863, trials were made on board Her Majesty's ship *Fearless*, the results shown being that while the consumption of Monmouthshire coal in the production of the same indicated horse-power was in one case 40 per cent. and in another 20 per cent. less than that of the north country coals, the former produced smoke in a medium volume of light colour, and the north country coal emitted large volumes of black smoke. This memorial was signed by the leading colliery proprietors of the county, and a reply has just been received from the lords of the Admiralty stating that the restrictions will henceforth be removed, and instructions to that effect have been given to the proper officers. The decision arrived at has given great satisfaction, and the result will be that the Monmouthshire and north country coals will in future be placed on the same footing as regards navy contracts.

The Goldfields at Victoria.—A new goldfield has been discovered about 18 or 19 miles from Dandenong, near the Emerald. The sinking is about 18 feet deep. Good yields are reported from the various centres of mining industry, but no goldfield seems able to compete with Ballarat in this respect. The last quarterly report of the Avonclift Company showed that the yield of gold for the half-year had been 2587 oz., out of which £4500 had been paid in dividends. The quarterly report of the Bonshaw Company shows receipts £14,120, £3300 paid in dividends, with a credit balance of £789, and that since commencing operations a sum of £15,144 has been paid in dividends. The Working Miners' Company paid £9600 in dividends last quarter. A nugget weighing 17 oz. 5 dwt. has been found in the workings of the Lady Don Company. On the 18th of February, 1867, the Great Western Company bottomed on one of the richest prospects of washdirt which have been found in the district for some years. A sample of the earth was shown about, and it is said that it could not be broken in any way without gold being seen in the fracture.—*Argus Supplement.*

Engraving upon Glass with Hydrofluoric Acid.—The engraver is often at a loss for utensils to hold his acid, but Stolba mentions that ordinary glass and porcelain vessels are protected from the action of the acid by paraffine. A thin coating of this material is easily given to a vessel by first of all carefully drying it, and then melting some paraffine in it, taking care to get the vessel rather hot; it must then be rapidly moved about to get the whole of the inner surface evenly covered, and the excess of paraffine may then be poured out. Vessels prepared in this way may be substituted for those of lead and gutta-percha.—*Am. Artizan.*

Preparing Oxygen Gas.—Several accidents have happened, and some lives have been lost, while preparing oxygen gas from chloride of potash and oxide of manganese in retorts made for the very purpose. Professor Doremus, of New York, uses merely a common iron tea-kettle, puts in his materials, lutes down the lid with clay or plaster of Paris, and attaches the tube to the spout. When placed over the fire, the kettle is tilted a little backwards. Now, if the gas should come off very tumultuously, the worst that can happen in this case is that the lid of the kettle will be blown off.—*Am. Artizan.*

M. Gaudin, some years ago, made exceedingly hard iron by combining it with a small quantity of boron. He has now produced an equally hard material by combining fused cast iron with phosphate of iron and peroxide of manganese. The mixture cannot be forged, but is easily cast, and can thus be applied to the manufacture of machines.—*Am. Artizan.*

Lighthouses.—There are six lighthouses now in course of construction by the British government—one situated on the Little Basses Rock at Ceylon, one on the Roman Rocks at the Cape of Good Hope, two in the Bahamas (on Castle Island and Imagua Island), one on Sombrero Island, and one on the Dellamara Point at Malta.

NEW GUN.—A gun has been invented in France in which electricity is used for igniting the charge. Two electric batteries are inclosed in the stock, the conducting wires of which project at the surface near the breech, and by a simple means are connected at pleasure with a fine platinum wire within the charge, so as to render it incandescent, and thus ignite the powder.

THE OAKS COLLIERY.—Mr. Dickinson, inspector of mines, has, without waiting for the completion of his annual report, presented so much of it as relates to the Oaks colliery explosion of December, which he has to designate as the most serious calamity which has occurred in any colliery in this, or perhaps in any country. 286 dead men remain yet in the pit, and 361 lives in all were lost. A long time must still elapse for extinguishing the fire before the pits can be safely reopened. But, except in the magnitude of the loss of life, Mr. Dickinson declares that there is nothing in which the explosion differs from a large number of similar occurrences. There were large accumulations of fire-damp in the goaves; the hour of the day was when it was warmest, the barometer was falling; active work had been going on all day, liberating more gas. There is no reason to suppose any extraordinary outburst. How the fire-damp became lighted is not clearly shown. Supposing no accident occurring to a safety lamp, there were open gas-lights for some distance from the down-cast shafts; blasting was proceeding, in driving a new stone drift from near those shafts, and it appears that a shot was fired with a very much larger charge of powder than usual, causing a considerable concussion in the air, and tending to disturb the gas accumulated in the goaves. The fire-damp may have been lighted at the allowed open lights along the old south level, and it would run back in a train to the goaves. The ventilation was skilfully laid out, and there seems to have been no want of care or discipline; but Mr. Dickinson is clear that the explosion is to be attributed to the system upon which the colliery was worked, which was the long-wall system and the old Barnsley system. He maintains that it behoves the mining engineers to take the matter into their most serious consideration forthwith, in order that a more suitable system may be introduced. It must be a work of time, even if set about at once. For his own part he says, "It may be premature to suggest at present what in my opinion the system should be, but from what has come under my observation I am strongly impressed with the view that the system which I brought under the notice of the Select Committee of the House of Commons on mines last year, and to the extension of which system in my own district I attributed the diminution which had taken place in the number of accidents and lives lost, concurrently with a large increase in the number of persons employed, is suitable for this seam. Under this system the levels are first driven out to the far ends, and the coal worked back from the extremities, having a substantial pack-wall built about three yards in width at the side of each working face. In this way all the goaves are left behind, and the pack-walls support the roof, and enable the ventilation to be kept up in the goaves sufficiently far from the working faces. By having more men in the same face of work than only two in from about eight to as much as thirty yards, as practised at Barnsley, the space of pit-room requisite to be kept open at one time might be much lessened, and the ventilation simplified. In Lancashire as many as eight men are sometimes put into such spaces of work as the above named. . . . It has been suggested that the area of coal to be worked by a pair of shafts and the number of persons allowed to be down at one time should be limited; and this view is entertained by some mining engineers whose opinions I respect. For my own part I consider that we live in the days of progress, and that as the sinkings become deeper we shall have to extend the area and increase the number of men. I look for increased saving to having the workings upon a proper system, such as I have recommended, and which answers well, and is found to be economical in the long run in my own district." So far as concerns the recommendation of the jury that there should be more strict inspection, Mr. Dickinson adheres to the opinion that this would tend to lessen the responsibility of owners and managers, and weaken the position of the inspector as a disinterested authority.

THE BRAZIL DIAMOND MINE.—In a recent notice in the *Boston Leader* of these extraordinary mines it is said, "We have received a letter from Mr. H. M. Lane, who has just visited the diamond mines of Brazil, and tells us that in taking the gems from the earth a driver places his gang of slaves in a mud-hole where the gems are found, and pans out the earth in the water like gold-washers. The negroes are naked, to prevent them secreting the diamonds in their clothes. They are required to work facing the overseer, and are forbidden to raise a hand to the face, lest they should swallow the jewels when found. Yet they do carry them away, by becoming so expert that they can snap them with their fingers from the pan to the mouth without detection.

CALF LEATHER.—Writing in the *Gerber Zeitung*, M. Schwabe, so well known for the superior treatment which leather receives at his hands, remarks—"I employ no secret arts to make my hides tender, but use only water. I use a fulling machine for leather similar to that used in fulling cloth. After heating my upper leather hides in this a second time, they are so tender that they can be put in lime without being stretched; after from sixteen to twenty days' liming the unhaired and shaved hides are again handled, and by this operation they are so thoroughly cleared of lime, that it is unnecessary to slick them, and they need to be rubbed down only to clear off the hair. Immediately after this I handle them a third time, and this in water, so it may be regarded rather as a washing. Although my upper leather has been handled for the fourth time, and sometimes the fifth in warm water after the stuffing, yet after another smearing I obtain a thick, pliable, but not loose leather in the side and neck. I am of the opinion that frequent handling is very effective in producing good upper leather, and I doubt whether an equally good result can be gained by any shorter process. I put the clean leather into a fresh liquor set in motion by means of a reel. It remains here three days, four in the second liquors, and eight in the third, where it is not stirred. By this process the ordinary disadvantages of handling are avoided, and a thick firm leather is gained."

SATURATED PEAT AS FUEL.—In the early part of the present month Messrs. Field, of Lambeth, who are known to have been for some time encouraging the application of the mineral oils for generating steam in lieu of coal in steam boilers, placed one of their boilers at the disposal of Mr. Vincent Lee. There is nothing whatever new in the saturating of peats with oil, and then using it as fuel; experiments have been made with peat so treated on numerous occasions, giving, we believe, as many different results. As we are anxious, however, to place on record everything that may tend to bring about the end sought, which we feel must yet be effected, we add the following particulars:—The furnace in which this peat fuel was burnt is worked by the new process of generating steam by burning coal oils, the combustion being assisted by the introduction of superheated steam. The boiler is a 10-feet Cornish one, the fire-grate being 4 feet 4 inches by 2 feet 3 inches, and the power is 10-horse nominal. The steam was got up in forty minutes by the peat fuel, and the maximum pressure of 30 lbs. per square inch, to which the valve was loaded, was reached in another thirty-five minutes. In a similar boiler it took three hours to gain the same amount of pressure. In each case the steam was kept in the boiler during the progress of the experiment. It was proved that 84 lbs. weight of Lee's patent peat fuel got up steam in less than one-half the time taken by Aberdare coal, although 1 cwt. of the latter is required to equal the performance of the peat. The smoke on firing up is rather dense, but a much smaller volume is given out from this peat than from north-country coals. At times no smoke was visible, and the colour generally was of a light brown. The peat fuel does not leave any ashes or cinders, and, consequently, cannot clinker or choke the fire-bars. The residue is like the ash from tobacco. There was no opportunity of testing its power of keeping steam up after being raised, or of ascertaining the quantity of water a given weight of fuel will evaporate.

ABERDEEN THE GREATEST ENVELOPE-MAKING CITY IN THE WORLD.—The Aberdonians would seem to be scarcely less celebrated for the manufacture of paper than they are for granite, ships, and combs. Few might be inclined to believe that one million of "superfine envelopes" are made daily in this remote region of the kingdom. But in addition to this, the firm of A. Pirie & Sons manufactures fifty tons of writing paper a week. At their mills at Stoneywood, in the vicinity of Aberdeen, and at the Union Works (the envelope department) in the city itself, they give employment to somewhere about 2000 persons, and as far as regards envelopes, the great proportion of which are folded and stamped by machinery, the Piries are believed to be the greatest makers of the present day. They confine themselves to the production of note paper, envelopes, and cards. The business was commenced by the grandfather of the present partners in the year 1770. The manufacture of grey, brown, and tea paper is carried on at Waterton and Muggiemoss, two mills a few miles north of Aberdeen, belonging to Charles Davidson & Sons. This firm turn out 86 tons of paper weekly, and 15 tons of grocers' paper bags, for which latter they have a machine capable of doing the work of twenty women in any given time. They employ altogether about 250 hands. The extent of the Aberdeen paper trade may be gathered from the fact that there are five paper mills within fifteen miles of the city, whereat no fewer than 2500 persons find employment.—*Paper Trade Review.*

APPLICATIONS FOR
PROVISIONAL PROTECTION FOR INVENTIONS
UNDER THE PATENT LAW AMENDMENT ACT.

☞ When the city or town is not mentioned, London is to be understood.

11th April, 1867.

1071 F. G. Fleury, Southwark—Measuring fluids
1072 A. C. Kirk, Glasgow—Blowing engines
1073 Robert Day, Pimlico—Painter's easel
1074 Richard Couchman, Noble Street—Fastenings for braces, belts, or bands
1075 Samuel Smith, Princes Street—Sporting guns
1076 Samuel Barlow and Thomas Edmeston, Stakehill—Furnaces
1077 W. R. Lake, Chancery Lane—Multiplying power.—A com.
1078 W. R. Lake, Chancery Lane—Manufacturing bricks.—A com.
1079 James Higgins and T. S. Whitworth, Salford—Spinning cotton
1080 William Clark, Chancery Lane—Vermin traps.—A com.
1081 George Slater, St. John's Road—Sewing machines
1082 T. A. Rochussen, Abchurch Lane—Armour plating
1083 J. J. Snow, Wilstead Street—Locomotive figures and automata
1084 James Dunbar, Westminster Chambers—Exhibiting advertisements
1085 Reginald Courtenay, Somerset Street—Propelling vessels

12th April, 1867.

1086 H. A. Bonneville, Bayswater—Railway sleepers.—A com.
1087 W. H. Dawes, West Bromwich—Manufacture of iron
1088 William Roberson and J. G. Orchar, Dundee—Finishing textile fabrics
1089 H. P. Boyd, Low Walker—Screws for fixing armour plates
1090 J. W. Wallis, Sowerby Bridge—Wrappers for woollen fabrics
1091 Constant Wilmet, Brussels—Accelerated tanning
1092 R. L. Hattersley, Keighley, and John Smith, Sutton—Looms
1093 C. H. Gardner, West Harding Street, and J. Bickerton, Oldham—Lithographic printing machines
1094 H. B. de Beaumont, Geneva—Ploughs
1095 T. H. Head, Stockton-on-Tees—Rolling iron and steel
1096 William Clark, Chancery Lane—Propelling vessels.—A com.
1097 William Clark, Chancery Lane—Clocks.—A com.

13th April, 1867.

1098 Robert Shortrede, Surbiton—Finding the variation of the compass
1099 John Aitken, Tottington Higher End—Refining sugar
1100 K. H. Cornish, South Molton Street—Fire-arms
1101 Ebenezer Stevens, Pentonville Road—Sharpeners for edged tools
1102 John Shore, Birmingham—Self-tighting valve cock
1103 John Jobson, Derby—Kitchen ranges
1104 C. G. Gillyatt, Wickenby Manor—Water drills
1105 William Gregory, Ardwick—Polishing metal
1106 R. S. M. Vaughan and A. G. Harston, London—Window latch
1107 Charles Crockford, Holywell—Obtaining useful products from the process of galvanizing iron with zinc
1108 Charles Grace, Liverpool—Rudder pins
1109 R. L. Hattersley, Keighley—Looms
1110 John Richardson and Charles Greenwood, Harrogate—Coupling railway carriages
1111 A. A. Langley, Chapel-en-le-Frith—Railway brakes
1112 G. T. Bousfield, Brixton—Manufacture of files.—A com.
1113 Robert Alexander, Islington—Compositions to preserve metals
1114 Samuel Harrison, West Street—Watches
1115 William Clark, Chancery Lane—Typographic printing machines.—A com.
1116 William Clark, Chancery Lane—Machines for printing.—A com.
1117 J. W. Cochran, New York, U.S.—Fire-arms

PARIS EXHIBITION, 1867.

LOCOMOTIVES.

(*Illustrated by Plates* 6 *and* 7.)

In the following columns will be found as intelligible and complete an account as perhaps it is practicable to give, of the locomotive machinery exhibited at the Champ de Mars, without diverging into criticism upon each, member by member. Nor would the doing even that be either interesting or profitable to the special professional reader, unless we could present before him also an immense atlas of detailed plates, without which it would be vain to attempt minute and yet intelligible mechanical criticism. To the general professional reader of the *Practical Mechanic's Journal* it may be enough to say, here he may find generally described all the chief characteristics of the nearly three dozen of engines exhibited; and from the accompanying Plates 6 and 7, he can see at a glance the general types of their arrangement.

The information that can be thus given, however, is to the engine builder very much of the same degree or kind as is conveyed to the comparative anatomist by such diagrams as show the nature of the limbs and their relational positions, and which serve with him to fix the order and class of living locomotive organisms. All deeper and minuter knowledge—all that upon which conclusions can be founded, whether anatomical or pathological—must be obtained by the physiologist in the dissecting room or in the hospital; and so the engine builder, or locomotive superintendent, who requires to have more than a general panoramic picture of the existing state of locomotive-engine construction laid before him, must follow the same thorny path towards full and exact knowledge, and must see and examine the engines for himself at Paris, and compare their minute anatomy with that of those with which he is already acquainted, and deduce from his experiences, in the running engine, and repairing sheds, conclusions as to the health and longevity of the engines now being presented to him, in the future struggle of locomotive life, on just the same sort of methods as does the physiologist when examining the like conditions of the living being. Of course we mean this rather as an illustration than as an analogy, and push it no further.

A few broad conclusions may be suggested, such as they have presented themselves to us when examining these locomotives.

In 1862 the foreign locomotives exhibited were chiefly remarkable for great magnitude, daring departure from pre-established form occasionally, and for the determinate effort to carry out *principles*, where these had been recognized as sound, without much regard to the degree of complication which it might, or at least *did*, involve.

To magnify the total weight of the engine so as to obtain at once great insistent total adhesion, along with immense steam-producing power; and yet by dividing the load upon a large number of pairs of wheels, and coupling all of these to the motor, to derive tractile advantage from all with an equally diffused and small individual pressure upon each wheel, has been the *beau ideal* in principle set before himself by the French locomotive engineer.

He has also, upon the whole, steadily endeavoured to avoid the employment of cranked axles, by the employment of outside cylinders. These involving outside valve gear, proportioned to valves and cylinders of a great relative size, inevitably became attended with more or less complication of parts and motions, which appeared the greater because they were nearly all visible to the eye, and fixed externally to the framing of the engine. The French mechanic, trained in a severe and geometric school, and with a clear current of scientific thought always flowing concurrently with his inventive faculties, is not easily deterred in carrying out into practice any notion that on principle has become a favourite with him; no amount of kinematic difficulty, no *gaucherie* of parts, stands in his way.

Hence to the English eye, and to the mind of the English mechanic, always habituated to make principle compromise with practice, for such results as simplicity in forms, reduction in number, and easy accessibility of parts, the chief impression, at all events the first and most common impression, produced by the foreign locomotives of 1862, was that of unwise, needless, and excessive complexity—we might say, of want of sound judgment in the adaptation of design, as a whole, in most instances.

There is much to remark *now*, though the interval in time is not great, to prove how great has been the advance since made in engine building on the Continent.

We find the same general principles adhered to; rightly, because right for once, principles are right for ever. We find them even extended; but the methods of carrying them out have been in many respects modified and improved, the details reduced, the constructions simplified.

The diffusion of the total weight over a number of pairs of wholly coupled wheels has been extended; and to this has been superadded the uniting into pairs of pairs, in the form of the American bogie, a smaller or greater number of these. This, together with the adaptation from us, and, so far as we know, from ideas first promulgated by Mr. Adams, of the curvilinear and self-adjustable axle bearings in the horizontal plane, have practically limited the length of these vast ten or twelve wheeled engines (not including tender wheels) to the length between one pair of coupled wheels, in respect to the facility of such engines for going round curves, free from danger or distress to themselves, or to the road. These numerous conditions, so hard to combine in practice, have been very ably carried out in some of the foreign engines now produced. Still in one example, the Haswell engine, wherein *all* have been pushed with consummate mechanical ingenuity to the last point as to completeness of fulfilment, it cannot be denied that the result has been only obtained at the sacrifice of simplicity, and at the risk of derangement, and the certainty of a higher coefficient of annual cost of repair. It is no doubt a fallacy, though frequently repeated, that the liability to derangement of any two machines having the same object to attain, is in the direct ratio of the number of moving parts in each. The special probabilities of derangement of *each piece*, *per se*, must be estimated, as well as the mere multiplication of pieces, before any exact expression of comparative derangeability can be arrived at. Still, in a rude general sort of way, it is no doubt a fact, that the more moving parts in any machine, the more likelihood of some derangement in some of them; and when, as in every locomotive, the connection of parts is such that in almost every conceivable case, the derangement of one is the derangement of the whole, complication is one of the very first things to be avoided. In this respect, the mere multiplication of parts in the locomotive occupies a totally different position from the multiplication of *similar parts* in other machinery; such, for example, as cotton-spinning machines.

The analogy is not between the locomotive and one entire range of cotton machinery, involving perhaps a thousand spindles, viewed as a whole, but between the locomotive and one single train—*i.e.*, one spindle, and all that appertains to its movements between the motor and the "spool" or "can." In fact, the derangement of one part here is the derangement of the one-thousandth part of the system; the derangement of one part in the locomotive is the temporary destruction of the whole.

The far greater simplicity, therefore, that still characterizes the British locomotives, though it be obtained by compromises, is never to be underrated. Some of the most remarkable points of improvement which characterize alike the British and foreign engines in the present Exhibition, are (like the locomotive itself) of British origin. Amongst these is the system of burning raw coal and the consumption of smoke, or rather non-production of it. This has, undoubtedly, been carried out in practice in a more perfect manner, and by more exact as well as more varied means, upon some of the great French railways than upon our own, more especially upon those of the west of France.

Efforts of a very persevering and well-directed character have also been made to substitute steel plates for copper for the firebox proper in the smoke-consuming boilers. In this, as well as in the general adaptation of steel plates to constructive purposes, we have let ourselves be greatly surpassed by both France and Prussia. It is only one case of that which characterizes nearly everything noteworthy in the machinery zones of this Exhibition, that the country which has brought forth the Bessemer steel itself, is left behind in its applications by other nations which have instantly taken up that great discovery. It is also apparent on all sides, as well as in this instance, that foreign nations are not merely prompt and efficient copyists, but that they are copyists with the intelligence and the knowledge and resolve necessary to be improvers upon the original.

Trustworthy plates of rolled cast steel 3 or 4 yards long by 2 yards wide, without a flaw or a defect, being enough to make a whole firebox in one if need be, are, we think we may say, as yet not produced, if producible, in Great Britain. Yet there they are, in the annex of the Commanderie Company of France; while not only that company,

but Cail & Co. and some other exhibitors, prove by the presentation of the most wonderful *tours de force* in the way of bending and "raising up" and welding up, cast-steel plate work, that France possesses boiler-plate smiths of an adroitness in the handling of this speciality, quite equal if not before any we have in England. And in referring to this generally, we may add that there are specimens exhibited in all directions by France, Belgium, and Prussia, we might add by Austria and Sweden, of forged "uses" in steel and in iron, and of the most difficult stamped or "die-work," as well as manual blacksmith's work, such as that of the wheelsmith, all of great and occasionally of startling excellence.

The Giffard Injector, which owes its origination to France, and (unlike many another French or other foreign invention) has been promptly taken up by ourselves, is now found we might almost say (though two or three exceptions appear) universally adapted to the locomotive. The injector itself has been improved and simplified.

The use of the housed-in hood to protect the engine driver, though hitherto unpardonably neglected in England, now presents itself on two English engines, that of Stephenson and of Kitson, and in different forms. The hood is almost universal, and has long been so, upon continental and American engines. Climate has in these cases compelled to that, which we ourselves should in wisdom have long since made imperative in our milder country. It is not a question of humanity to the workman, as many seem to think it at first sight, but of increased safety to the life and property involved in the safe conduct of every train. The most iron-nerved and eagle-eyed engine driver is a different man in his powers of observation and promptitude, when his faculties are unimpaired by exposure, to what he is, after he has run through miles and hours of mirk darkness, and wind and rain or sleet driving into his face and eyes, with a force and velocity (due to perhaps his own and their proper motions) not equalled by the most violent storm.

Steel tyres, steel wheels, steel shafts and cranks, all show their rapidly increased employment. The steam brake upon all the wheels to which it can be applied (vertically and upon the top surface of the tyre), shows itself in the Haswell engine.

One of the complications inevitable to the system of multiple-wheeled engines is the necessity for a corresponding increase in the number of the brakes, and the tremendous multiplication of levers, rods, and toggle joints that becomes involved for acting on the brake blocks. In the immediate future nothing seems more probable than that brakes on this class of engines, acting by blocks upon the treads of the tyres, will be abandoned wholly, and some entirely new expedient employed of a simpler and more powerful character for gripping or otherwise arresting the rotation simultaneously of all the wheels, by the power of the engine itself. Notwithstanding the power of brake in the Haswell engine, it seems to us problematical whether any very efficient, we might almost say sensible, resistance would be opposed to the progress of this ponderous engine upon a moderate descent, by all the brake power that can be commanded.

The history of the locomotive engine from its very cradle to the present hour, and to its existing stage of efficiency, if not perfection, has been that of patchwork; one small improvement after another, slowly but constantly resulting from trial and error, from the unrelaxed efforts of many instructed minds, always employing judgment and exacter knowledge in unison. It is not, therefore, to be expected that any salient or, so to say, "wonderful" advance, or such as the popular voice would recognize as such a sort of improvement, should be encountered now at Paris. That day, the day for popular wonder, was passed when the Rainhill trial was run, and no such visible and tangible demonstration of dimly imagined but unrealized and unthought-out hidden powers, is likely to be repeated in our day at least; though he would be a bold rather than a wise man who will venture to deny the possibility that combinations of chemical and molecular (or strictly physical) forces together, such as are imaginable in relation to the Carré Ice (Ammonia) machine, or the slow combustion of gun cotton, or others, may not yet give to man a command over locomotion, in certain directions, vastly exceeding anything that solid fuel and high-pressure steam have yet achieved. But for the moment we have to contemplate only small advances, and these affecting details. These are presented in the minuter details of the locomotives exhibited in very numerous particulars. Better and more philosophic forms in special parts exposed to strain, are frequent. Greater attention is everywhere apparent in providing for the better *condition* of the engine while running, and for the reduction of the "small cares" of the engine driver and stoker. Self-acting oil cups and grease cocks are more numerous, better constructed, and more judiciously applied.

In general stamp of what we may call "a vigorous constitution" and good running powers, the English engines, especially those of Stephenson and Kitson, at once address the technical eye, as well as in their general grace of mechanical form and goodness of finish. Were we to fix upon a single foreign engine which appeared to us to possess these qualities in a high degree (where all shown nearly are so good), we should probably fix upon either of the two following, exhibited by France, viz., the engine from the workshop of the Chemin de Fer du Midi, with two outside cylinders and six coupled wheels, which is a fine simple substantial job; or that from the manufactory of Gräffenstaden, intended for the Chemin de Fer de l'Est, of France, also with six coupled wheels.

No engine in the whole collection of foreigners will probably so universally startle the attention of the English visitor, as that exhibited in Germany from the Machine Fabrik of Eslingen, of Wirtemburg, designed by Emil Kessler, as construeting engineer, at least so we gathered, named THE DELHI, and ordered with, as we were informed, several more by the Great India Railway Company for one of its branches.

It would be a subject worthy of careful and sufficient research, whether the occurrence of a phenomenon so untoward and so unlooked for by Englishmen as this is, may be due to some temporary and exceptional cause, or whether it be a real indication of the fact that the country which created both railway and locomotives, has at last, through the steady and rapid advance in industrial power of the continental nations during the last forty years of precious peace, at last found her rival in her own speciality in the foreigner, at even her own door. In tools and in workmanship the advance of the continental nations, since even 1862, has been immense. Any competent mechanic who goes through the great machinery zone and annexes of the Champ de Mars, with the selection and observation necessary, will soon become convinced that there is nothing which the workman's hand, commanding machine tools as good as the world can produce (for to say nothing of their own chief and truly excellent tool makers, the tools of Whitworth and of our other great British makers are spread broadcast abroad), can do which the foreigner is not quite as competent to do now, as the Englishman. The former has superadded the immense advantages of a generally better rudimentary and technical education, and in a good many cases of that which is in part the consequence, a more orderly and regular habit of life and industry. The general subject of comparative workmanship, and to what it tends as regards respective national futures, we cannot discuss here.

We may state, however, that while taken *as a whole*, it may be just possible to say that the workmanship of the British engines is (also as a whole) superior to that of the foreign ones, it is as fully true that the workmanship of *some* of the foreign engines is, *as a whole*, perfectly as good as that of the British ones; and that taken *piece by piece*, so far as it is possible to compare workmanship without having steam up, and the engine on the rails and under one's own eye and hand, there is little to find fault with in that of our foreign rivals, and that their progress since 1862 has been immense.

We are to some extent indebted to the *Etudes sur l'Exposition de* 1867, by M. Eug. Lacroix, for the following description of the Locomotive engines in the Paris Exhibition, and for the plate engravings which accompany our notice.

The Paris Exhibition comprises thirty-three railway locomotives, without taking into consideration drawings and models; and the competition really partakes of an international character. The following are the numbers contributed by the countries named:—

France, ...	14	locomotives.
Prussia, Germany, and Austria, ...	8	"
Belgium, ...	5	"
England, ...	5	"
United States, ...	1	"

Under the class of locomotives with auxiliary tenders, we find, in addition to an auxiliary tender engine exhibited by the Est Railway Company, drawings of the Fairlie and Urban engines on the same system. The Fairlie engine (shown at fig. 1, Plate 7) is the counterpart of the Sturrock system; it is characterized by the peculiar mechanical arrangement, the large tubular body of the boiler, and the arrangement of the coupled wheels in two sets, jointed so as to pass round sharp curves. For this purpose neither the boiler of the locomotive nor the

PARIS EXHIBITION.
LOCOMOTIVE ENGINES.

Fig 1

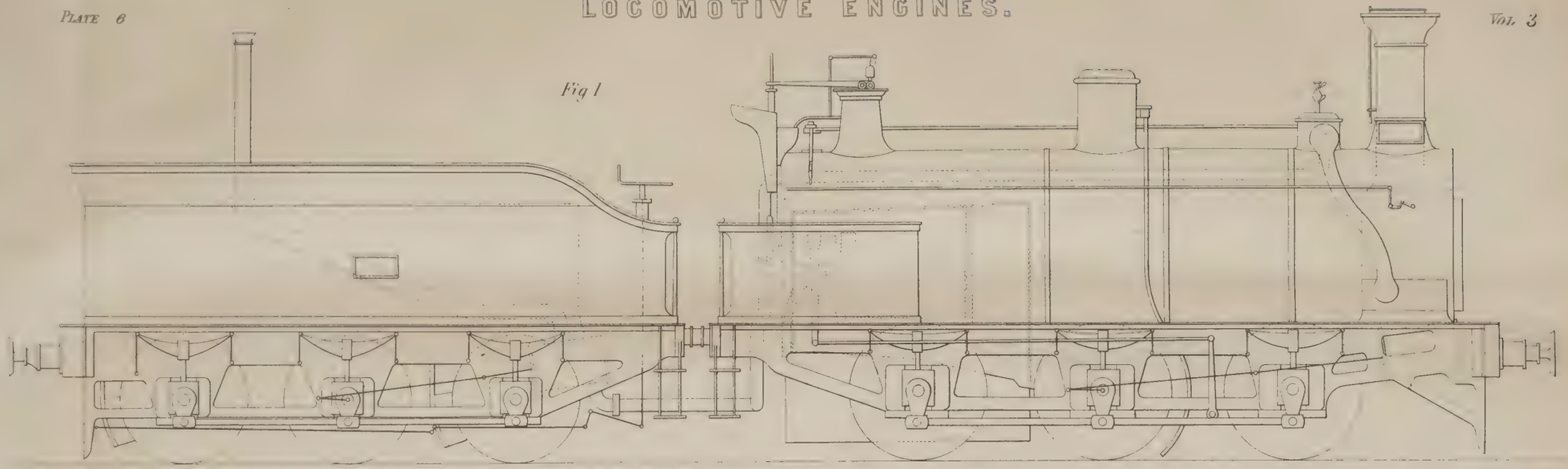
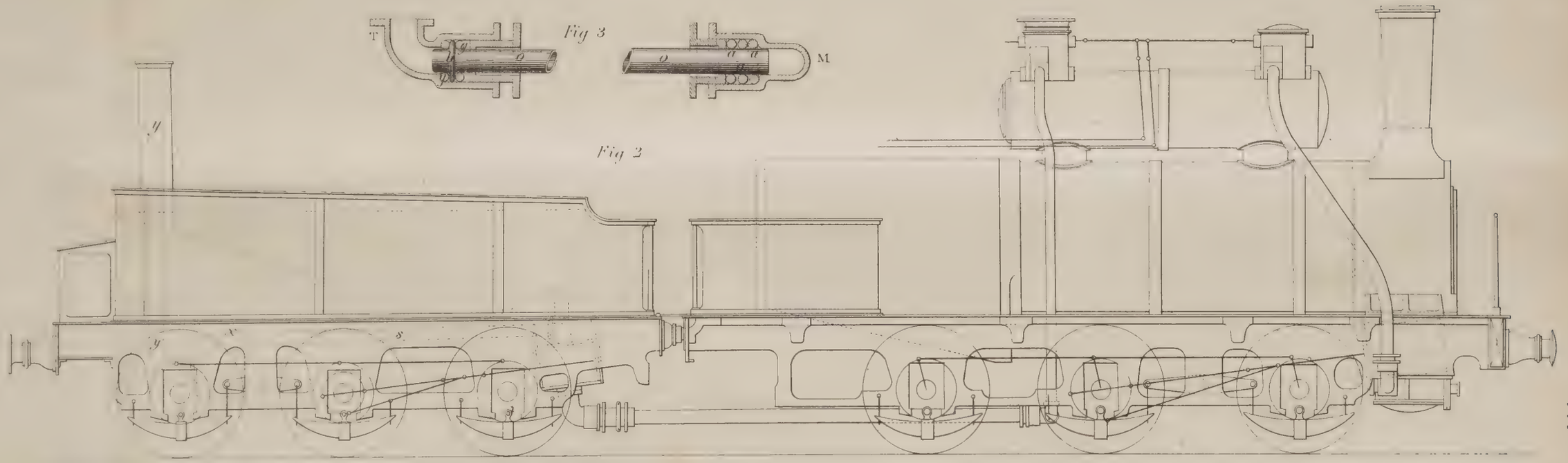


Fig 3

Fig 2



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LOCOMOTIVE ENGINES.

PLATE 7

Fig 1

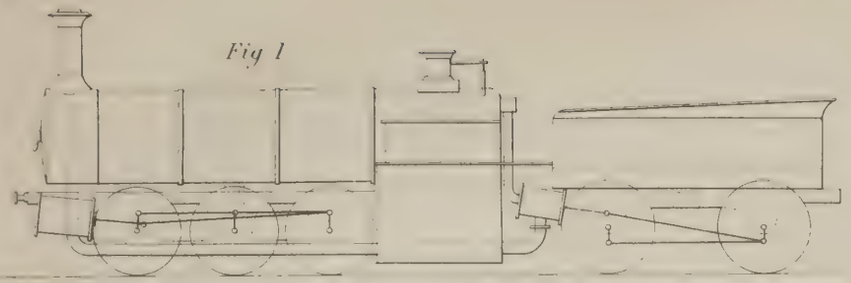


Fig 7

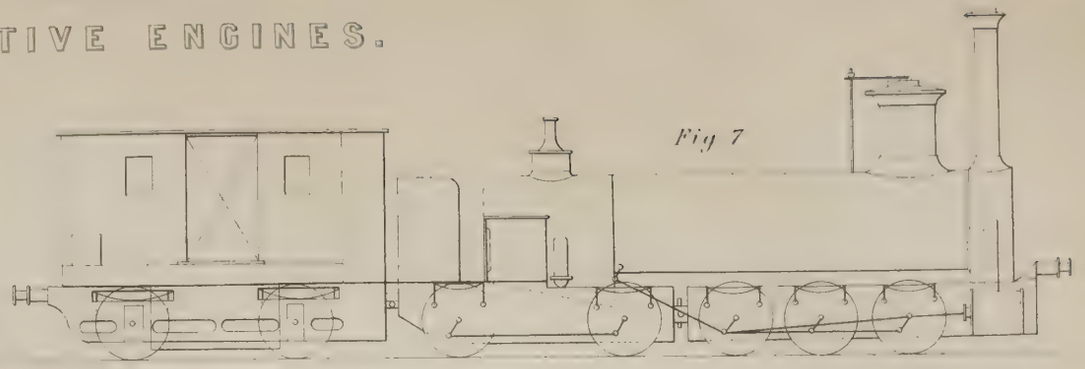


Fig 6

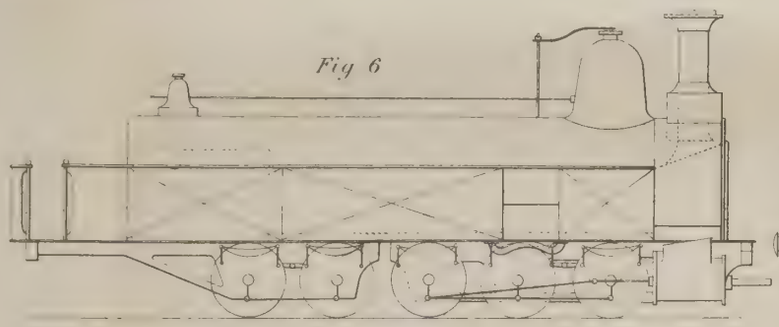


Fig 9

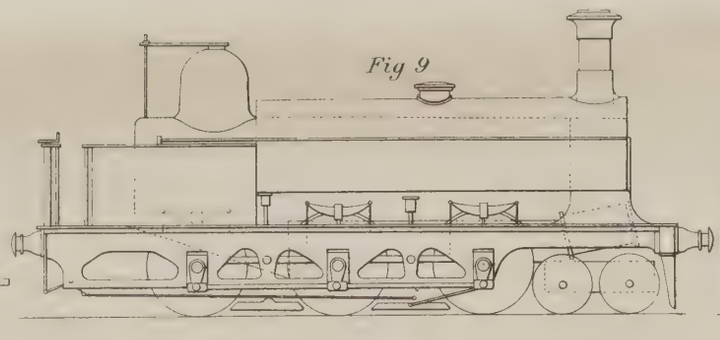


Fig 8

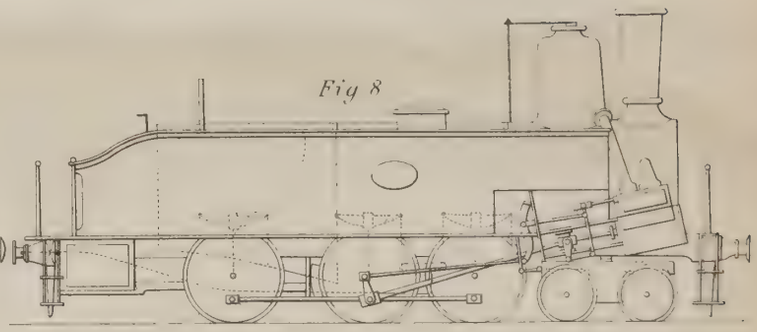


Fig 2

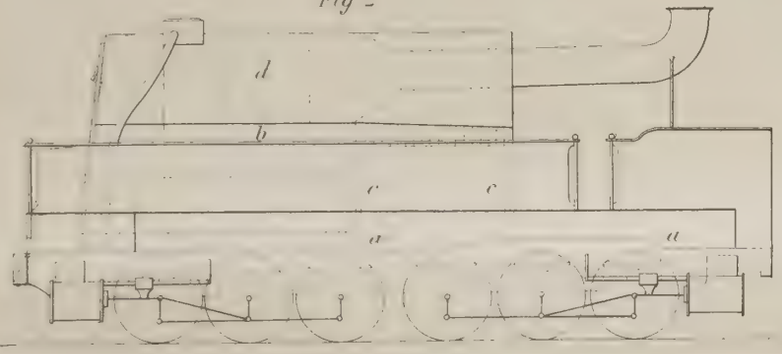


Fig 4

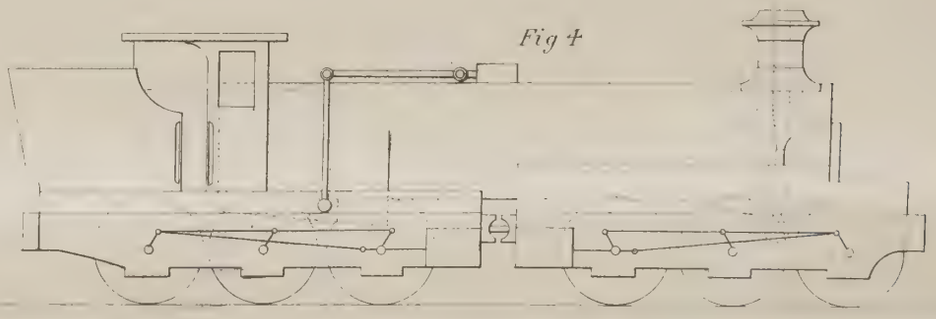


Fig 3

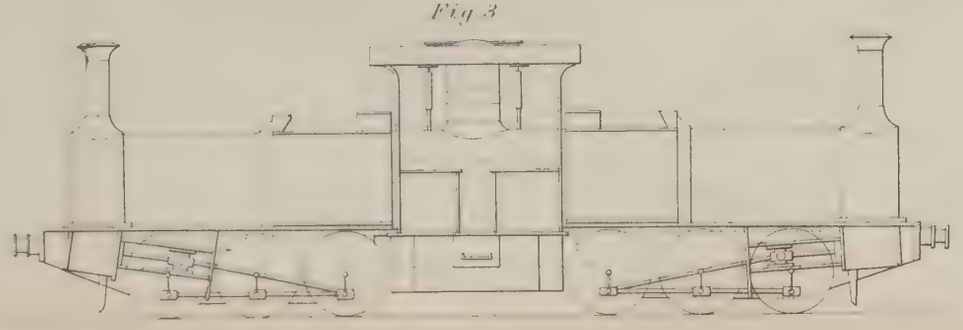
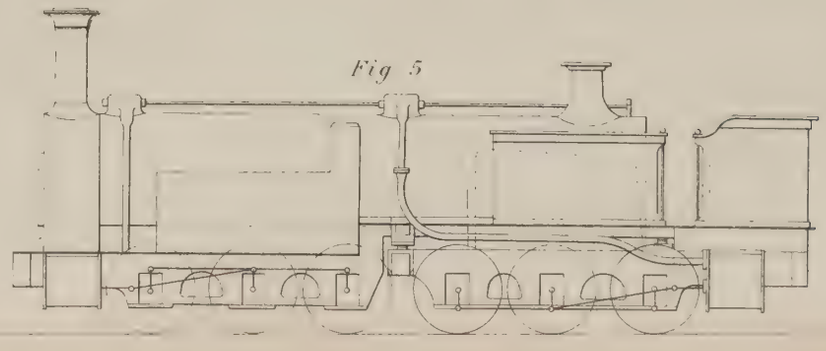


Fig 5



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water-tank of the tender are fixed to the frame, as in the ordinary system; but the body and the wheels are arranged on the 'bogie' plan, in jointed sets capable of lateral motion in passing round curves. The boiler and water-tank are mounted on knee-joints, round which the frames turn. The following are further particulars of engines of the Fairlie type:—Boiler with long tubes, 4·10 metres; a vertical water space in the middle of the firebox; outside cylinders slightly inclined, valve apparatus inside; simple frames, suspension springs under the axles, arranged so as to equally support the weight of the engine. The steam is supplied to the tender by means of a short bent tube, leading from the front of the firebox; and after acting in the cylinders, it escapes, as in the ordinary system, through the chimney by a long flexible tube under the boiler, similar to that used in the Sturrock engines.

The Urban engine (see fig. 2, Plate 6), the drawings of which are exhibited by the Great Central Railway of Belgium, was constructed at the Company's works, Louvain, from the design of M. Maurice Urban, engineer-in-chief. It is intended to draw trains of 246 tons (exclusive of its own weight) at a speed of 20 kilometres on a line in which some of the curves are of a radius of not more than 500 metres, and where there are inclines of from 10 to 18 millimetres in 28 kilometres. By means of its powerful boiler it can generate sufficient steam to constantly supply the four cylinders. The following are its chief peculiarities, viz., a long firebox on the Belpaire system, with canopy attached by stays, substituted for the ordinary fastenings; inclined grate, with fine bars to burn small coal; the hind axle supports in the middle the firebox, which is of extra width, as is also the firegrate, which has been inserted in front; conical chimney, tapering towards the bottom; tubular body, nearly full of tubes, having at its top a cylindrical reservoir as in the Urban engine; inside driving gear; simple frames outside the wheels; springs underneath axles, with equilibrium beams from the front to the driving wheels. Tender with six wheels, same kind of frame. The distribution of the steam is effected by hand through the medium of excentrics, the engine sufficing to direct the course. Communication of steam by a tube placed under the boiler, in the axis of the engine, and jointed at its two ends by the mechanism shown in fig. 3, Plate 6 (drawn to a scale of one-tenth the actual size). At the engine end, M, the tube, O, O, is held in an air-tight joint within three rings of vulcanized caoutchouc, *a*, *a*, *a*, placed at the bottom of a stuffing box, of a funnel or trumpet mouth. At the tender end, T, the pipe is provided with a flange, *b*, formed on it, and fitted between two rings, *g*, *g*, similar to those before described. The steam discharged from the cylinders of the tender passes under the tank through two tubes, *s*, *s*, into a box, *x*, from whence it escapes into the air through the outlet, *y*. The following are some of the dimensions:—Inclined firebars, 2·27 × 1·04 = 2·36; capacity of the steam chest, 1300 litres; diameter of driving axle journal, 190 millimetres; distance between axis of the cylinders, in the engine 0·68, in the tender 0·72; length of driving connecting rods of engine, 1·76; do. of tender, 1·20 metre; diameter of piston rod, 55 millimetres; dimensions of engine frame, of wrought iron, length, 7·85, thickness, 23 millimetres; do. of the tender, length, 5·90, thickness, 20 millimetres.

M. Vuillemin, engineer-in-chief of the Eastern Railway of France, in conjunction with M. Mesmer, of Graffenstaden, has designed, on the system of Mr. Sturrock, an excellent specimen of locomotive (see fig. 1, Plate 6), the only actual engine with auxiliary tender in the Exhibition. It was built at the Graffenstaden Works, and is intended more especially for the local traffic of such portions of the line where heavy gradients more frequently occur. The inside motion is arranged in a manner somewhat similar to that of the Sturrock engines, with a simple frame outside the wheels, and coupled cranks on the axle journals, as applied to some of M. Polonceau's engines on the Orleans Railway. The wheels of the tender are rather smaller than those of the engine. The lifting of the slides is effected by a hand-lever or a screw. The boiler is very strong, with inclined firebars, short tubes, and a very large amount of direct heating surface through the furnace; the latter is supported at about its centre by the hind wheels, and is provided with two doors and a space for water, which descends freely from the roof of the furnace: this has to be added to the exhibited engine. The steam is introduced to the tender cylinders through a long flexible tube similar to that used in the Sturrock engines, and escapes by another tube into the air. The boiler is of steel, and the parts of the motion also of cast steel. The engine was tried twice before being sent to the Exhibition, and, with the aid of the auxiliary tender, drew with ease a load of 580 tons at a speed of 25 kilometres over gradients of 5 millimetres, and occasionally round curves.

FOUR-CYLINDER ENGINES (LOCOMOTIVE AND TENDER COMBINED).

This class of engine is represented at the Exhibition by the colossal locomotive of the Northern Railway of France, and by several drawings and models, among which is a drawing of the Fairlie engine, which has been the subject of much controversy here. In an important lawsuit to which this kind of engine gave rise, it was proved that the system had been patented about thirty times, both in England and France, under every variety of form, both with double boiler and boiler of the ordinary description.

We come now to the specimens of this class of engines in the Exhibition.

Nord-Gouin (fig. 2, Plate 7). A drawing of an engine of this type was exhibited at the International Exhibition of 1862, where it was the subject of much interest, and being so antagonistic to English ideas, angry invectives were lavished upon this bold conception of the Northern Railway. Notwithstanding all this, the result of five years' working of the first ten engines with the goods traffic, and that over a line frequently interspersed with heavy gradients, has been so satisfactory that a fresh order has just been given for a further supply of engines of this class. These engines were built by M. Gouin, Clichy, from the designs of the engineers of the line. The following are the chief particulars of the one exhibited:—It has twelve wheels, forming two independent sets, each set being provided with its own driving gear, of which the valve and the top slide (one to each set) are worthy of observation. On the simple frame is first placed the water tank, *a*; above this the boiler, *b*, with its firebox, *c*, on the Belpaire system, not very deep, but long and wide, and projecting sideways above the frames and the wheels. Above the boiler and communicating with it, is the steam chest, *d*, with tubes passing through it; the size of the tubes is, outside diameter, 80 millimetres; length, 0·80 metres, and they have 15 m.g. of heating surface. Next to this is another tubular body, *e*, provided with an equal number of tubes of the same diameter, but 1·10 metre in length, and comprising 20 m.g. of heating surface; this serves to heat the feed water, which is carried back to the boiler by the pumps; and, in addition, there is an injector which may be used when the engine is standing. The chimney is horizontal and peculiar to the engines of this line, which are too high for the ordinary vertical chimney, and it appears from the experiments of MM. Nozo and Geoffroy that the position is immaterial, and that chimneys with a forced draught of the same dimensions answer equally well whatever be their position.

The means by which the mechanism is thrown out of gear is also worthy of observation; the entire independence of the two sets of wheels, and their gear, except the lifting lever, which is common to the two and easy to manipulate, the four slides arranged so that when one set is in the upper position the other will be down. The axle springs are all suspended in the same group by means of beams, and the end axles are capable of lateral play. The engine runs at full speed round curves of 250 metres radius, and will even traverse curves of 150 metres at a diminished speed. A large tube contains the water and steam pipes, and it is inclosed in the boiler casing.

Fairlie (see fig. 3, Plate 7). A drawing of an engine on this system by Fairlie, is also exhibited; it was built by James Cross of St. Helens, from the designs of Mr. Fairlie, for the Southern and Western Railway of Queensland—a line on which there are some heavy gradients. Its peculiarities are as follows, viz.:—1, The rectangular firebox with side doors, and placed between two tubular bodies of similar form, making a total length of 11·50 metres, comprising the smoke boxes, which are provided with chimneys of the ordinary kind, but fitted with a hood or cover to arrest the sparks. 2. The wheels and driving gear form two independent sets, one over each side of the fireboxes, and turn in a body on a pin fixed under the middle of the tubular boiler. 3. The steam supply and discharge pipes are jointed so as to be capable of lateral motion. 4. The valve slides of the inverted type are details worthy of note, also the method of lifting, and the reversing lever moved by a screw jack, and the arrangement of the water tanks forming part of the pivoted bodies.

J. J. Meyer and Ad. Meyer (fig. 4, Plate 7). These engineers have exhibited drawings of various specimens of mountain locomotives, of the same class as those exhibited in 1862, but slightly modified. One

is now in course of construction at Cail's Engine Works. There is but one boiler, which, resting on two movable bodies or frames, to which it is secured by three jointed supports; one situated on the fore body, in the axis of the boiler, and the other two on the hind body; these two bodies or frames are united by a "spreader," subjected only to a tension strain, and are capable of motion in any direction.

The fore body carries the water and the hind one the fuel. There are four sets of driving gear, but only one steam chest for the four cylinders, from which the steam is supplied to the cylinders by flexible tubes, as in Sturrock's auxiliary-tender locomotive, and in that of the East Railway. A part of the steam discharged from the cylinders is utilized for the purpose of partially heating the feed water, and the remainder escapes by a flexible tube through the chimney, which is of a circular form. The driving gear is outside the wheels, as well as the frames, with outside connecting rods, the head of which forms a fusee after the German method, and patented by M. Meyer in 1851. The engine which we have selected from those of M. Meyer, is intended for passenger traffic up steep inclines; the wheels are 1·50 metre in diameter, and the distance between the fore and hind wheels of each set and between the two sets 3·20 metres. The other engines with wheels of 1·20 metre diameter, and a distance between the extreme axes of 3 metres, are similar in construction. MM. Meyer also exhibit drawings of four other descriptions of engines.

Thouvenot, St. Maurice (Switzerland), exhibits drawings of four cylinder locomotives for the passage of the Valais; they have twelve wheels, two sets of six, each set pivoted on the "bogie" plan, and have a double boiler. They are somewhat similar in general appearance to the Fairlie engine, but in consequence of their large firebox, and the size of the tubular boiler, the latter is capable of generating a large quantity of steam, and the cylinders instead of projecting as in the Fairlie engine are brought nearer to the firebox.

Boutmy (fig. 5, Plate 7). M. Boutmy, locomotive superintendent of the Lyons Railway, exhibits a drawing (one-fifth the size) of an engine designed by him in 1862. It has two sets of six wheels each, and separate driving gear. The boiler is firmly secured to the framing of the front set, and is pivoted to the hind set, bogie fashion. The steam pipe is flexible, as in the auxiliary-tender engine of the East Railway. As M. Boutmy justly observes, the engine is a combination of the Engerth and of the Urban-Sturrock system. The water tank is on the front fixed body, partly underneath the boiler, as in the large Nord engine, whilst the fuel is on the jointed hind body. It has inside frames and driving gear, outside cylinders; each set has its steam pipe, but one screw and wheel mechanism lifts the four slides.

MOUNTAIN LOCOMOTIVES OF VARIOUS SYSTEMS INTENDED FOR STEEP GRADIENTS.

Forquenot (fig. 6, Plate 7). This engine, built by the Orleans Railway Company at Ivry, from the designs of M. Forquenot, is intended to run on a portion of the Cantal, where there are heavy gradients of 30 millimetres in 18 kilometres and sharp curves of 300 metres radius. It is of the combined engine and tender description, with ten pairs of coupled wheels and a very large steel boiler. The water tanks and the place for the fuel are situated on the side platforms. The gear is disposed outside. The lifting of the slides is effected by a screw motion. Large firebox. The frame is partly internal and partly external; it passes inside the three front pairs of wheels, then bulges out and runs along outside the two hind pairs of wheels, the journals of which have large cranks, on the German system. There is no jointed body, as in the following examples; requisite lateral play being provided in the axle boxes, and by a special arrangement which will be hereinafter described. The driving wheels are fixed, the two fore and the two hind pairs are free to move from 7 to 17 millimetres each side of their boxes, and the driving connecting rods are hollowed so as to accommodate themselves thereto, and the coupling rods fitted with a ball and socket joint for the same purpose. The heads of the rods are provided with hoops, instead of "ears" as in the ordinary way. The load on the axles is—on the two fore axles 11·38 tons, on the driving axle 12 tons, and on the two hind axles 12·120 tons. The square box beneath the chimney is a sand pit; a coal hole tool-box and water tanks are provided, the latter being united at the bottom by elbow-pipes.

Haswell. Austrian locomotive called Steierdorf (fig. 7, Plate 7). This engine was built at the works of the State Railway, Vienna, under the direction of M. Engerth, for the coal traffic on the line from Steierdorf to Orawitza, and was exhibited at the Exhibition of 1862, since which time it has been running. The weight on each axle is not more than 9½ tons, and the total weight 45 tons, as it was not considered safe to employ heavier engines on so light a road (Vignole's rails, 25 kilogrammes per metre), and it was calculated that this engine ought to draw a train of 110 tons up an incline of 20 millimetres, with curves of 114 metres radius at a speed of from 11 to 15 kilometres; but it appears, from a communication made to La Société des Ingénieurs, January 18, 1867, that it has in its working exceeded the estimate formed of it, and it continues to run satisfactorily, requiring but little repair, and the mechanism acting perfectly. One of the (*faux*) axles, intermediate shafts transmissive of power to the other axles of the coupled wheels, which was too weak, had to be replaced, however, the tender lightened, and the distribution of the weight modified, and a portable water tank added behind.

The engine is composed of two jointed bodies on which the boiler rests, and is secured to the fore body which carries the inside mechanism, and is supported on three pairs of coupled wheels, and the firebox is jointed on the Engerth plan to the hind body, carrying four coupled wheels, to which motion is communicated by a false-axle mechanism with jointed parallelograms, arranged so as to be susceptible of lateral motion. This is the fundamental principle of the Steierdorf engine. It appears that this principle was first applied by Kirchweyer, in Hanover, and subsequently by MM. Lippert, Gouin, and Larpent; but in 1856 M. Engerth undertook with all his staff to investigate the question, and the plan adopted in this engine was then devised by one of his sub-engineers, M. Pius Fink. The false axle, placed over the fore wheels of the tender, governs and is governed by the connecting rods; it is attached to the wheels of both bodies by rods which secure a parallel motion, and the whole is rendered flexible by means of the spherical form of the journals, false axles and bearings, and the driving connecting rods.

Another peculiarity of this engine consists in a steam brake placed under the boiler, and acting on the four pairs of wheels of the engine by means of a lever motion; it has vertical cylinders 0·197 metre in diameter and 0·250 metre stroke, and the arrangement is found very advantageous in descending steep inclines. The engine has outside gearing, excepting the valves which are inside the wheels. The wheels are of cast iron (*à double flasque bombée*) on the Ganz system; outside frame of the German type, and cranked axles.

Waessen, Liege (fig. 8, Plate 7). This so-called universal train engine was built at the St. Leonard Works from the plans of M. Waessen, managing engineer, and is similar to those of the North of Spain Railway. It is a locomotive with tender, combined in one; and its peculiarities consist in the outside mechanism being inclined, the use of a firebox on the Belpaire system, in a slide moved by a single excentric, and a connecting rod on the Walschaert system; also in the use of rods to place the springs in equilibrium, long since adopted by the Belgians and the Germans, and, above all, in the use of a bogie in front of two pairs of small wheels in addition to the six coupled wheels.

The coupling of the engine with the train is another peculiarity. The *spreader* passes under the engine, and is jointed in front of the driving axle. The bogie has also its coupling by means of a connecting rod which runs under the smokebox, and is there hooked. A large number of locomotives on this system, differing more or less in detail, have been built for various companies, especially for Spanish lines.

Sharp (fig. 9, Plate 7). A photograph is exhibited of this locomotive with tender, used on the incline known as the Bore-Ghaut, India. It has three pairs of coupled wheels, a bogie frame in front carrying four small wheels, friction brakes acting on the rails of the line, a water tank placed concentrically over the boiler, inside motions, thick wrought-iron outside frame, long firebox, with inclined firebars, and supported in the middle by the hind wheels.

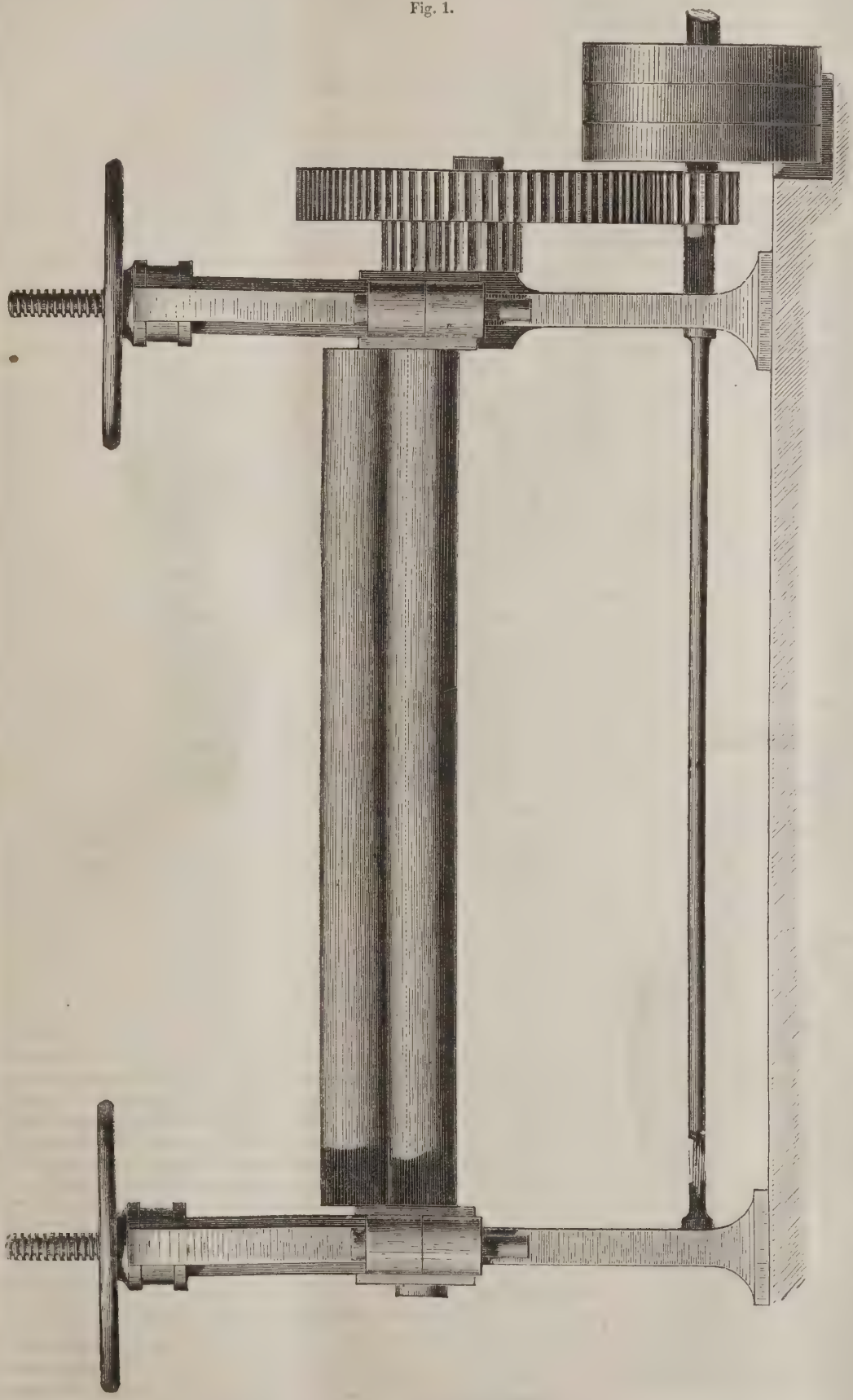
PLATE-BENDING MACHINE.

By Messrs. JOHN FLEMING & Co., Engineers, Glasgow.

EVER since the introduction of flue boilers, and still more of late, when the Admiralty and shipbuilders have introduced tubular iron and steel masts and spars, it has been felt as a great want the possession of a bending tool, combining not only the properties of reducing iron plates to true circular form, but also in its other arrangements capable of

allowing the tube to be withdrawn off the end of the top roller, without the necessity of first withdrawing the roller itself. This cannot be effected with the ordinary plate-bending rolls; and hence several plans have been devised, and some executed, having for their object the carrying out of what we allude to.

Fig. 1.



Nearly all, if not every design that has hitherto come under our notice, has consisted in some mode of taking out one of the bushes in which the top roller is carried—that being the roller on which the plate is converted into a tube. Such an arrangement, however, is extremely limited in regard to the diameter of tube thus enabled to be withdrawn, as it is evident that its diameter must be less than the breadth of openings in the end framing of the rolls.

Now that we are likely to obtain sound iron and steel plates of lengths and breadths sufficient to form an entire boiler shell, it needs no explanation to indicate how valuable a circling machine will be which enables tubes of any size to be withdrawn from it without the necessity of withdrawing the top roller, also enabling this to be expeditiously done. We believe we are perfectly warranted in stating that no machine hitherto devised will bend or circle plates of unlimited breadth into a complete circular tube, and allow such tubes to be removed from the machine endwise; and that in every case it is imperative to withdraw the top roller, after which the tube can be lifted directly off the two lower rollers on which it rests. This object, however, has been accomplished here in Glasgow within the last few weeks by Messrs. Fleming & Co.; and from what we have seen of the machine, there can be no doubt it will perfectly fulfil a want that our great iron industries have long felt.

The accompanying woodcuts, which are prepared from the working drawings, fully illustrate the arrangements.

Fig. 1 is a front elevation; figs. 2 and 3 are end elevations. It will be perceived that all the driving gear is fitted on one end of the machine, so that the other end is left entirely free and open, as shown by figs. 2 and 3. The bush block at the open end for carrying the top roller has only a half bearing to resist the upward pressure of the roller when at work, and the roller is kept in its place by a connecting link and pin (not shown); so that when a plate has been bent into a circle, such as a flue, mast, or funnel, by withdrawing the pin of the connecting link, and raising the block, the work can be drawn off through the opening in the frame, as shown at fig. 2; and to relieve the weight of the roller from the plate while it is being drawn off, a round lever of iron for this purpose can be inserted in the small opening in the end of the roller. In so far as the manufacture of masts, spars, funnels, domes, flues, &c., is

concerned, this arrangement is particularly adapted. And it will be seen from fig. 3 that provision has been made for bending plates into circles up to any diameter. The frame is made in two pieces, bound together with strong cottered bolts; so that when it occurs that a tube has been bent larger than can pass out through the opening in the frame, the sliding block has simply to be raised to clear the journal; and by withdrawing one of the cotters and bolts, the top part of the frame is turned round out of the way, and the work may then be got off, as shown by fig. 3; or the top part of the frame may be lifted out of the way with a rope suspended from the roof, as is found most suitable.

Fig. 3.

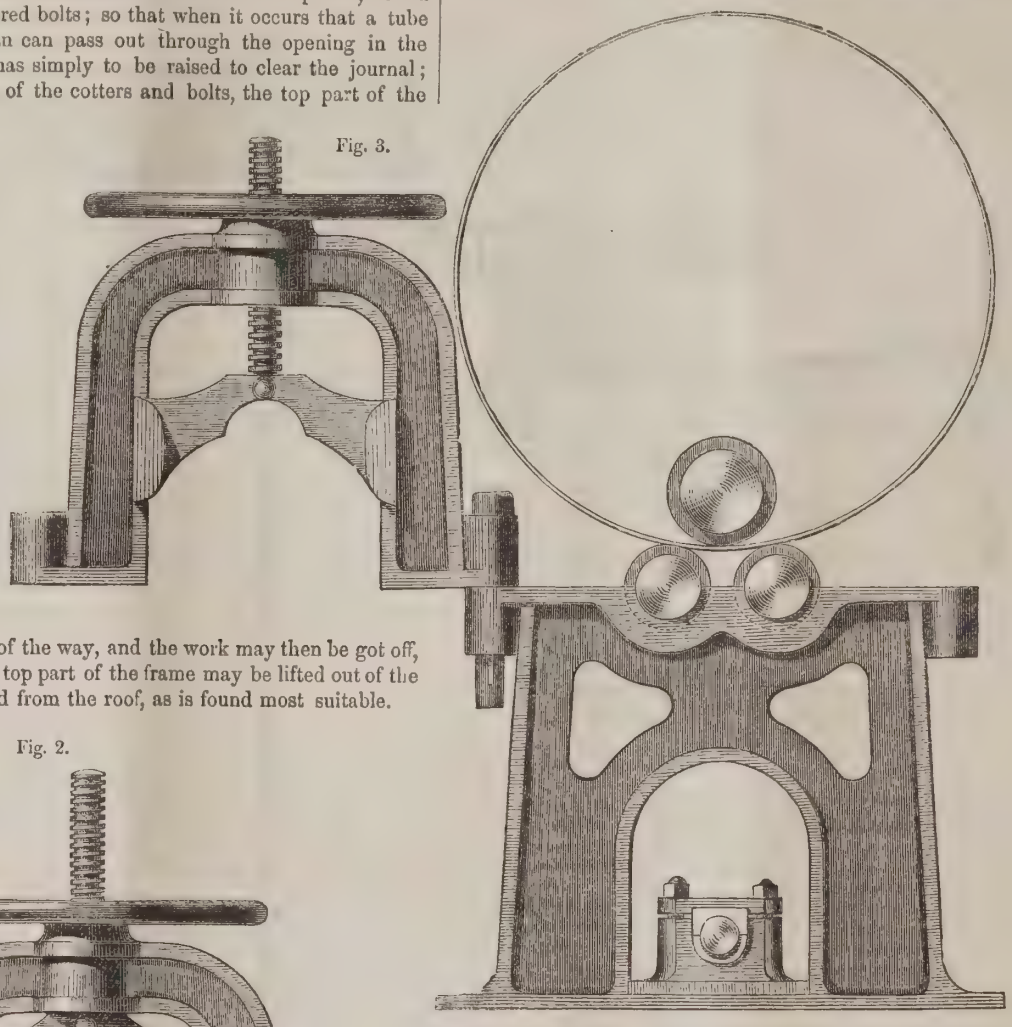
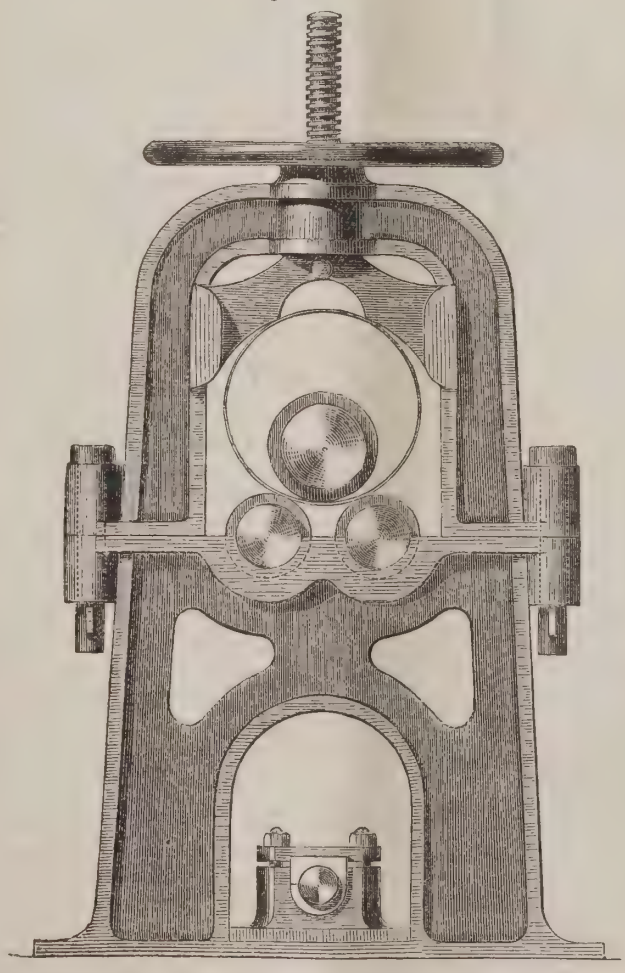


Fig. 2.



This machine has other advantages over those made with the top roller to draw out. When so made, a great amount of space is requisite at *each* end of the machine to admit the men to draw the roller out and in; and in the case of a large machine, it takes a large number of men to do so; but with the machine above described, space is required at *one* end only of the machine; and it can be easily understood that the plates will be drawn off more quickly and easily than hitherto.

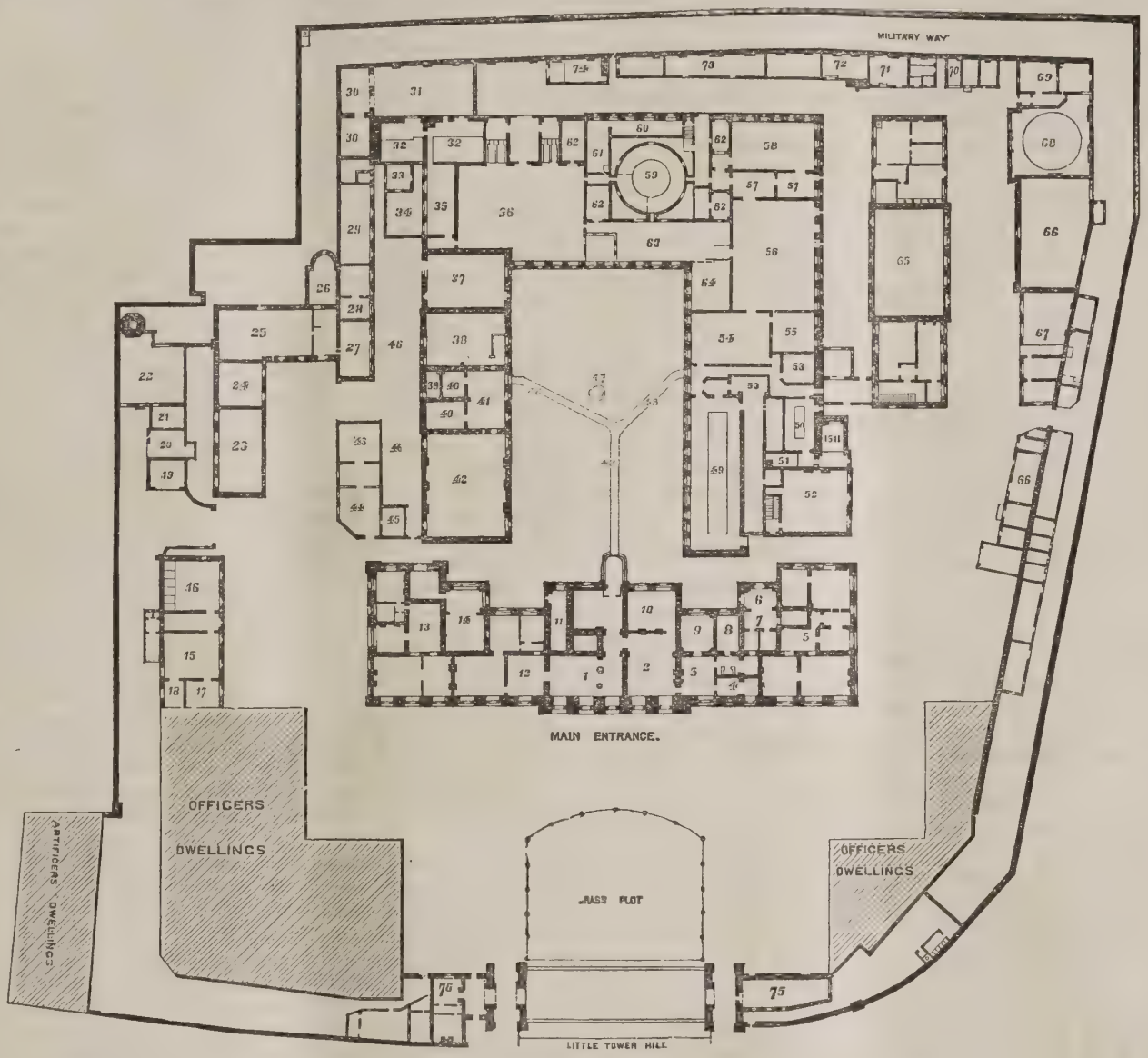
Further than this we need not add, as a careful inspection of the illustrations will indicate whatever else there may be that we have not alluded to.—V. D.

COIN AND COINING.

By J. Newton, Esq., Royal Mint.

It is intended in the course of a short series of papers on this subject, to explain the various and interesting operations carried on within the walls of her Majesty's Mint; and to describe verbally, or by illustration, some of the principal machines employed in that establishment. Without tracing the progress made in the art of coining from those early days in the history of this country when all manufacturing arts were conducted by means the most rude and primitive, and which would have more interest for the antiquarian than the practical man of our own time, we shall presently proceed with an account of coining as it is. The Mint is a very complete and extensive manufactory, covering, with officers' dwellings, &c., about seven acres of ground; and it is situated immediately to the east of the Tower of London. It was built at a cost of a quarter of a million sterling (between the years 1805 and 1810); and the celebrated architect Smirke designed it, and superintended its erection. The site now occupied by the Royal Mint was chosen mainly because the government already possessed certain buildings which covered a portion of it, and it was therefore only necessary that some adjacent houses should be purchased and removed in order to provide a sufficient area for the new establishment. This was one of the arguments employed in Parliament by the ministry of the day, and it gained

force from the fact that the Tower with its garrison was near at hand for the protection of the proposed money manufactory. The buildings already in the tenancy of the crown consisted of a tobacco warehouse and a victualling office for the supply of the navy; but these had become comparatively useless, in consequence of the transference of the business of both departments to the royal dockyard at Deptford. Some discussion arose upon the whole question in the House of Commons, and one member suggested that Somerset House might well be appropriated for the reception of the machinery and appliances of the Mint; but finally the arrangement first named was agreed to, and hence the present noble but not pleasantly situated coining establishment, a ground plan of which we here introduce.



1 Entrance Hall.
2 Mint Office.
3 Comptrollers' Office.
4 Bullion Stronghold.
5 Provost of the Moneyers (Residence).
6 Laboratory.
7 Master of Mint Assay.
8 Residence of Master's Assay Master.
9 Coin Stronghold.
10 Pix Office.
11 Residences of Bullion Porter and Office Keeper.
12 Residence of Deputy Master.
13 Residence of Queen's Assay Master.
14 Laboratory Queen's Assay.
15 Die Press Room.
16 Die Annealing Room.
17 Office.
18 Stronghold.
19 Coach House.
20 Boiler House.
21 Tank.
22 Refinery.
23 Smiths' Shop.
24 Die Forgers' Shop.
25 Turning Lathes, Vices.
26 Engine Room.
27 Boiler House.
28 Refiners' Room.
29 Charcoal.
30 Coals.
31 Reservoir.
32 Boiler House.
33 Wood House.
34 40 H.P. Engine House.
35 Engine Room.
36 Rolling Mill Room.
37 Grinding Room.
38 Gold Melting House.
39 Residence of Surveyor of the Melting.
40 Stronghold.
41 Office.
42 Silver Melting House.
43 Stronghold.
44 Copper Store.
45 Store Room.
46 Melting House Yard.
47 Well.
48 Tramway.
49 Coining Press Room.
50 Coining Engine House.
51 Boiler House.
52 Office.
53 Strongholds.
54 Shaking Room.
55 Pickling and Blanch Room.
56 Annealing Room.
57 Presses for Annealing.
58 Marking Room.
59 Cutting Out Room.
60 Engine Room.
61 Boiler House.
62 Strongholds.
63 Adjusting Machines.
64 Lathe Room.
65 Automaton Balance Room
66 Bronze Office.
67 Carpenters' Dwelling.
68 Bronze Coin Store.
69 Gas-man's Apartments.
70 Fire Engine.
71 Smiths' Shop.
72 Brewhouse.
73 40 H.P. Engine House.
74 40 H.P. Engine House.
75 Guard Room.
76 Porter's Lodge.

It may be stated, before passing to the strict subject of this and following articles, that in the olden time—prior, indeed, to the reign of Queen Mary, who, like her less fortunate namesake, Mary Queen of Scots, paid much attention to coin and coining—there were several metropolitan and provincial mints in this country. The notorious Mint Street, in Southwark, derives its name from a mint that for many years existed in Suffolk House, which occupied part of the site of that street. In what is now known as Durham Street (Strand), but which owes its name to *Duresme* House, which once stood there, a mint also was in full action for many years. Canterbury, Winchester, and York cities, too, boasted their mints in days gone by; and, more remotely still, it was the custom for monarchs, and even some favoured dignitaries of the church, to employ detachments of men, known as moneyers, who accompanied their masters in their progresses through the country, and who cast and stamped money whenever the royal or archiepiscopal exchequers became too scantily furnished to meet current expenditure!

Inquiries into ancient minting operations have revealed to the writer many curious and highly interesting facts; whilst the laws and regulations which governed the movements of the operators are still more quaint and peculiar. Details of these cannot now be given, from lack of space and other obvious causes. It must suffice to say that during the rule of Queen Mary the whole of the mints of England were consolidated into one large establishment, which was situated within the Tower of London. There the national coinage was thenceforth struck, until the public demands for metallic currency outran the productive power of the place; and a new steam-power mint, outside the Tower walls, became an absolute necessity. This contingency really occurred towards the close of the last century, and hence the parliamentary discussion, resulting as has been described.

We may now, without further prelude, speak of coin and coining as they are managed at present.

The Royal Mint is now wholly under the control of the government, and is managed by a master, deputy-master, and superintendent of machinery, together with a not very numerous staff of officials of minor rank, and some seventy or eighty artificers and workpeople. Its steam-power consists of two engines, respectively of 40 horse-power and 20 horse-power, both of which are on the compound (or high and low pressure combined) principle, the larger having been constructed by Messrs. Hall, of Dartford, and the smaller by the Messrs. Rennie, of London. The maximum productive force of the Mint is equal to the creation of 200,000 pieces of money of any denomination per day of ten hours; but the extent to which this force is exerted depends upon the requirements of its sister establishment, the Bank of England.

The alternate depletion and repletion of the coffers of the Bank, and the causes of those phenomena, are points of some interest undoubtedly; but it is not essential that they should be entered upon at present. It may be imagined, for our purpose, that there is a strong efflux of gold and silver coin from the last-named place, and that it is desirable to supply the vacuum thus in course of formation with newly-minted money. If the outflow be in the form of gold, an intimation is forwarded by the governor and company of the Bank of England to the master of the Mint to the effect that he will, on an early and specified day, be required to receive an importation of ingots of that metal; and that such importations will be continued twice or thrice a week until further notice. True to the times named, wagons, with well-stored chests within them, and burly porters as escorts, arrive at Tower Hill. A "note" of the weight of each batch of ingots, "to the utmost carat," and of the "fineness of the gold," arrives with each argosy. The material is received and duly weighed by Mint officials, the weight being recorded in ounces and decimal parts of the ounce. Notes are then compared, receipts written, and the empty wagons depart.* Thus matters proceed until perhaps a million sterling in value, and ten tons in weight, of ingots have been received at the Mint. This quantity is deemed sufficient to warrant the putting in motion of the Mint machinery. Ere this is done, however, a careful and scrupulous assay of each individual ingot is made, and the result reported to the master. The identity of all the ingots is maintained (by stamping each of them with letters and numbers) until they reach the crucibles of the melting room; and thither they are next conveyed. The gold melting department of the Mint resembles nothing so much as an ordinary brass foundry. It has its air furnaces, its coke fires, its plumbago crucibles, and its moulds. These latter are, however, made of cast iron, and they are for the purpose of transforming molten ingots and alloy into bars of standard gold. The moulds are placed on carriages of iron, and are arranged in sets of twelve. They are so made as that, when bound together with iron bands and screws, recesses are left between each pair for the reception of the precious fluid. When the latter has solidified, the screws are slackened, the moulds fall asunder, and the bars are released.

Granting now that a supply of ingots has reached the melting room, let us see what next takes place. It has been stated that the ingots are assayed before being despatched to the melting room. The chief melter receives also a report as to their "betterness" or "worseness" than the true standard, which is twenty-two carat, that is, twenty-two parts fine gold, and two parts of alloy;† and as this may happen, so is he guided in admixing alloy (copper) or fine gold. This operation, however, is not performed with each ingot, but upon a given number, generally equalling in weight some 1200 oz. It is called technically "potting" ingots, or preparing them for the pots or crucibles. Excessively careful weighings, as may be imagined, attend these preliminary arrangements; and weighings indeed form the coiner's safeguards through all the processes of minting. They are his checks against peculation, and his pilots into the haven of exactitude. Whilst these preparatory steps are being taken by the officers in charge of the department, the workpeople are preparing the furnaces, crucibles, and moulds. There are seven furnaces, placed conveniently along the sides of the apartment; and each is arranged for the reception of one crucible. These latter are made of a composition formed of Stourbridge clay and plumbago, and they require careful annealing and gentle treatment to prevent fracture. In preparing them for the reception of gold and alloy, they are heated first to redness. Into each crucible six ingots are usually deposited, with such portions of fine copper as are needed. The contents are then in each case covered by a muffle or collar, resting on its rim and a cap, and the liquefaction proceeds.

The moulds, standing almost vertically on their frames, which latter again are supported by wheels running on tramways, are next advanced to the front of the furnaces. When the metal in the first crucible is sufficiently fluid for the purpose of pouring, it is stirred energetically, so as to produce complete incorporation of the gold and copper, and then the crucible is raised by aid of lever and tongs from its bed. A loop-ended bar of iron, and a line and hook dependent from the roof, enable two of the workpeople to lift the crucible and carry it to the mould frame: a gentle inclination, and the rich and scintillating, or at least sparkling, liquid runs into one of the moulds. It is quickly filled, and a coining bar is cast. Another and another follow. The "empties" are returned to the furnaces for re-charging, whilst full crucibles are in succession disinterred and disencumbered of their valuable freights. When one set of moulds is filled, its frame and it are pushed away along the little tramway towards a water cistern. Other moulds are advanced, filled, and removed; and so long as the material intended to be melted and poured on any given day lasts, so long similar performances take place. It happens sometimes, indeed, when the ancient dame of Threadneedle Street is impatient and pressing, that gold to the value of a quarter of a million sterling is transformed from ingots into coining bars in the space of eight hours. This may be termed "heavy work;" but fortunately the public do not "run for gold" as in days gone by, and the Mint is not often called upon to do it.

When it is desired to remove the bars from the moulds, the tie-rods which bind the latter together are loosened, and one by one their golden tenants are released. One by one they are also quenched in a cold water bath, and then laid side by side on an iron plate to dry. By aid of a chisel they are also trimmed, the chips being jealously preserved; and presently a weighing of the whole in batches follows. The loss in weight by volatilization of alloy and absorption by the crucibles are scrupulously noted; and the results, compared with the ingot and copper deliveries of the morning, determine whether all is *en règle*, or whether any of the metal may have unaccountably disappeared. The dimensions of rectangular bars for subsequent conversion into sovereigns are as follows:—Length, 24 inches; breadth, 1·37 inch; and thickness, 1 inch. The average weight of each bar is 320 oz. troy, and its value

* This statement applies in a minute and exact sense to gold only; when silver is wanted at the Bank, intimation of the fact is sent to the Mint, and the master purchases the material in the bullion market. He then causes its conversion into coin, and transfers the latter to the Bank.

† Determined by Act 56 Geo. III. c. 68, s. 11. The standard for silver coin, in pursuance of section 4, same Act of Parliament, is 11 oz. 2 dwts. fine silver to 18 dwts. alloy.

£1200; a costly "gold stick, in waiting" for its higher destiny—its crowning fortune! Bars for half-sovereigns are of the same length and thickness, but slightly less in width; and both are thus proportioned to facilitate their subsequent lamination, and to cause them ultimately to assume the exact width required for the respective pieces to be cut from them. Before anything further in the way of mechanical manipulation occurs to the bars, they have again to be assayed and stamped.

(To be continued.)

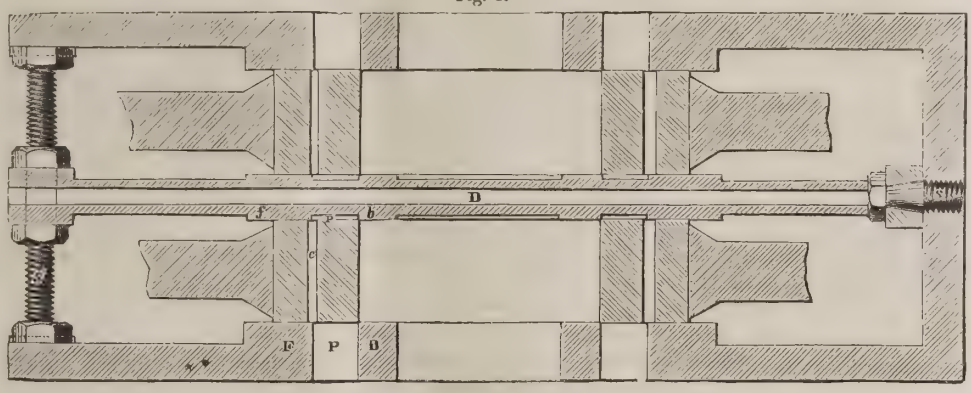
THE THEORY AND PRACTICE OF THE SLIDE VALVE.

By Mr. Thomas Adams, Engineer.

I.—*Of a Perfect Equilibrium Slide Valve.*

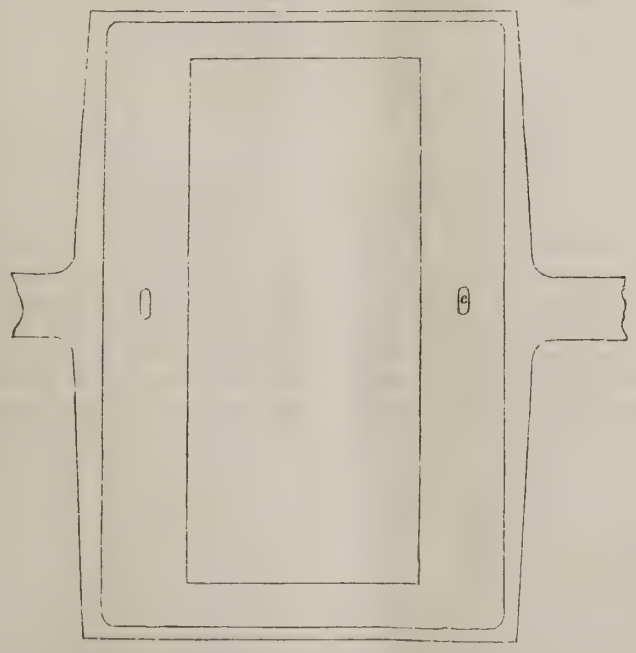
Fig. 1 is a horizontal section of a pair of perfect equilibrium slide valves, as applied to an inside cylinder locomotive on the North London and London and Brighton Railways, where parts corresponding to that marked F are the cylinder faces, P the admission ports, and B the bars. D is a division plate fixed on two studs, S, at the back end of the steam-

Fig. 1.



chest, and it is cast hollow for the passage of steam from one end of the chest to the other; S′ are horizontal studs, with check nuts on them by which to set the plate, D, in the centre of the chest. The parts marked *f*, *p*, *b*, on division plate, D, are equal and opposite to F, P, B, and form

Fig. 2.



a false cylinder face directly opposite to the true cylinder face; C is a communication port through the valve, shown also at fig. 2, which is a top plan of the valve.

The action of the steam on this valve is to press on the outside of the valve on equal and opposite sides simultaneously; the exhaust pressure presses on the inside, also on equal and opposite sides. Conceive now the valve to move from its middle position to that at the commencement of a stroke. The steam will enter one of the ports, P, according to the direction in which the valve is moved, and acting on the face of the valve by the area exposed over the port, would press the valve from the cylinder face. But the back of the valve has at the same instant opened the false port, *p*, of equal and opposite area, therefore both ends of the valve being similarly acted upon, the pressures are equilibrated. Let the valve move on to full port, gradually increasing the opening of the port, and as gradually decreasing the area of that portion of the valve face exposed to the pressure, until at full port it becomes reduced to *nil* on both sides. Let it now as gradually recede, increasing its area over the true and false port. It does so equally on both sides until the outer edge of the valve crosses the outer edge of the steam port, thereby causing the commencement of the period of expansion within the cylinder; but the communication port, C, is open between the true and false port; and whatever the decrease of pressure within the cylinder, the same takes place in the false port, *p*, until the inner edge of the valve crosses the inner edge of the port, determining the point of release within the cylinder, and it also releases from the false port, thus producing an equilibration of pressure on both sides of the valve in every position the valve may assume. At the same instant, the valve having neither inside lap nor clearance, has closed the opposite port to the exhaust, and whatever steam has not got out from the opposite end of the cylinder is compressed before the advancing piston, the pressure rising within the cylinder; but during this period and while the valve is crossing the port, the communication port, C, is open to the false port, *p*, thereby maintaining the pressures equal on both faces of the valve at the end opposite to that through which steam had been last admitted.

Having now performed a cycle of operations, it will be seen that the steam, under any variation of pressures, cannot touch this valve on any one point without touching it on an equal and opposite point, and practically at the same instant of time, and hence a perfect equilibrium slide valve.

But, alas! this beautiful valve, so perfect and delicate in theory, was at loggerheads with its less perfect and less delicate, but sterner companion, practice, whose coarser and erratic ways soon overcame its more delicate and weaker neighbour. These valves being well fitted, worked well so long as the steam was on the expanding chest and valves equally, but on shutting off the steam to run down an incline or into a station, the heat generated by the friction of the valve rubbing over the bars between the true and false ports, although initially very small, gradually increased every stroke; the valve, cylinder face, and division plate absorbed the heat so generated: and these parts expanding without expanding the sides of the steam chest, the result was that the valves stuck fast, and the valve spindles were severed, a period was soon put to the existence of a perfect equilibrium slide valve.

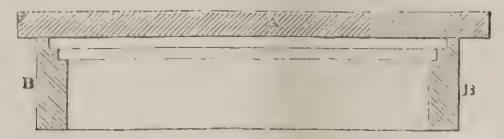
Seeing that no practical benefit can be derived from a perfect equilibrium valve, let us endeavour to make the most of an imperfect one, by displacing the greatest possible amount of steam on the back of the valve necessary in practice, so that the valve cannot be blown back from the cylinder face at any portion of the stroke. To arrive at this a number of experiments were made.

II.—*Of the Relation which Surface bears to Pressure when Moving Against or in a Highly Heated Fluid.*

Let B, fig. 3, represent in section a plain ring, and fitted steam-tight into the back of a valve by means of the scraper, with no packing whatever or set screws to deceive, by the uncertainty of force attendant on such appliances. With the top surface of the ring bearing against the door, A, of the steam chest, and a good strong spring under it to keep it in contact with the door, steam of low pressure, 5 lbs. in the square inch, was let on, when all the surfaces were found tight; at 10, 15, 20, and 25 lbs. all was tight, but at 26 lbs. a blow began, and the

higher the pressure was carried the greater the blow became (the section of the ring was ¾ inch thick). The ring was now taken out, and ¼ inch recessed out of the inside, as shown in fig. 3, leaving ½ inch breadth of bearing surface against the door. At 26 lbs. all was tight, also at 30 and 35; but as soon as the gauge showed 39 lbs. pressure, a blow was the consequence. The ring was again taken out, and another ¼ inch recessed out of the top side, as shown in fig. 3, leaving only ¼ inch breadth of bearing surface against the door. The steam was again let on, and at 26 and 39 lbs. all was tight; but true to the relation of surface to pressure, as the pressure rose to 78 lbs. a blow of steam was again the result. The spring was now taken out, and weighted to its working deflection, when it showed only a difference of 8 ozs. per square inch of bearing section when measured by the area of surface in contact, multiplied by the pressure, which plainly enough indicated that to hold

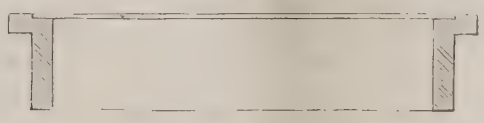
Fig. 3.



any surface in contact with another when moving against the pressure of a heated fluid, it must be held against such surface by a force equal to the area in contact, multiplied by the pressure.

This being the experiment with the ring, the next thing was to find the proper displacement of steam on the back of the valve; in other words, the proper diameter of ring. For that purpose a valve similar to fig. 8 was selected. A ring was put in, fitted steam-tight with the scraper, to displace by its dimensions the whole of the area of the valve, less the area of the two admission ports (this being the prevailing rule among engineers, and if a ring so large as this cannot be got in, one simply as large as can be introduced is adopted). The result of this experiment was, that the valve was blown back from the cylinder face, and a rush of steam struck out through the ports. A ring of less and less diameter was put in, displacing less and less area on the back of the valve, always

Fig. 4.



producing a heavy blow of steam through the ports as soon as the valve began to move, until finally one was put in which held the valve to the cylinder face, and there was no blow through any portion of the stroke. This last ring was taken out and measured, from the dimensions of which the rule of displacement for all valves with ordinary laps was deduced. Let fig. 9 be the plan of a valve, and X Y the diameter of ring for displacement. By the relation of surface to pressure, it is evident that the pressure will act on the whole of the valve outside the circle, X Y, on equal and opposite surfaces, and these will therefore balance themselves, except the two spaces, S S′, which are neither equal nor opposite (dealing now with one-fourth part of the valve).

The space, S, will have a surplus of pressure on the face of the valve to press it from the cylinder face, while the space, S′, being a portion of the exhaust cavity retained, will have a surplus of pressure on the back, and not on the face. It is, therefore, required that they be proportioned so that the moment of the one shall be practically equal to the moment of the other; to determine which, draw the line $\overline{n\,n'}$, leaving the spaces n, n', equal to m. The space is now a triangle, and is easily calculated: bisect the base, $\overline{n'\,o}$, at p, draw a line to the opposite angle, and one-third the distance will be the centre of action of the space, S, and measures 3·8 inches from the centre of valve. Then the base, multiplied by the perpendicular height, and divided by 2, will give the area, which, being multiplied by 3·8, the distance at which it acts from the centre of valve (which is the mean common fulcrum of all the forces), will give the moment. Thus—

$$\frac{2'''\cdot 8 \times 5}{2} \times 3\cdot 8 = 26 = \text{moment of S.}$$

And of the space, S′, which has the surplus pressure above and not below, draw the line $\overline{b\,d}$, leaving the space b outside the line of displacement equal to the space d inside; draw the diagonals $\overline{b\,e}$ and $\overline{d\,f}$, the point of intersection will be the centre of action of S′, and measures 5·7 inches from the centre of valve; then one side multiplied by the other, and by the distance with which it acts from the mean common fulcrum of the forces, will give the moment of effect. Thus:

$$2'''\cdot 5 \times 1\cdot 87 \times 5\cdot 7 = 26\cdot 6 = \text{moment of S′.}$$

The moment of the one being equal to that of the other, the valve will move as easily with steam of any pressure on as off.

Further experiments were now made with the top of the ring in order to further determine the relation of surface to pressure. Fig. 4 is a section of a ring with a flanch on the top to work against the door. The top and bottom of the flanch were of equal areas, but the recess was only a sixteenth deep. A strong spring was put under the ring to wear off the sixteenth of fillet, in order to get when worn off a larger area of surface in contact with the steam-chest door than there was exposed to pressure to hold it up to the door. The fillet soon got worn off, and the bottom of the recess then came in contact with the door, thereby increasing the area in contact with the door, the result of which was a blow of steam up the chimney. The ring was taken out, and the increase of area equalled 1½ square inches. The same ring was recessed deeper, leaving the top and bottom surfaces equal, and it worked perfectly. These experiments were made simultaneously on the North London Railway by Mr. Adams, and on the Great Eastern Railway by Mr. Sinclair.

Fig. 5 is also a section of another ring, the top and bottom areas of

Fig. 5.

which were equal at first, but the top of the ring was formed oblique internally, so that when it began to work it commenced to wear equally all round. At first this ring worked perfectly, but in a short time a blow commenced. It was taken out and measured, when it was found to be $\frac{3}{32}$ inches greater on the top section than the bottom. It was again recessed deeper than at first, and put in with equal surfaces at the top and bottom, when it again was quite tight.

These experiments are conclusive *of the existence of a film interposing itself between the surfaces of contact, when the body is immersed in the fluid and in motion; and adhering to the surfaces of the metal, it presses the surfaces apart with a force equal to the pressure in the steam chest. And although it is not free to pass between the surfaces as a leak or blow, it is there notwithstanding, existing as an elastic fluid, no matter how thin it may be; and so long as its temperature is maintained, it possesses all the energy of the surrounding steam.* It will therefore

Fig. 6.

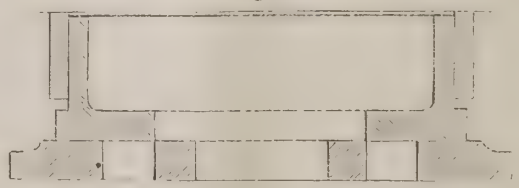
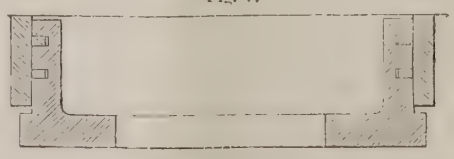


Fig. 7.



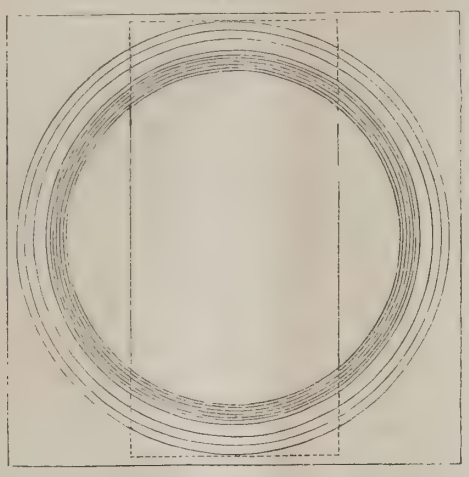
carry a certain load, which it does as the valve slides over it, and perform an amount of mechanical work equal to the heat contained in it; and when its heat is destroyed friction sets in.

Fig. 6 is a plane ring, having the inner surface of the ring and the outer surface of the cylindrical portion of the valve on which it fits

scraped and made steam-tight, and having no part of the valve outside it the steam acts beneath the ring.

Fig. 7 is the same form of ring, but having two Ramsbottom piston

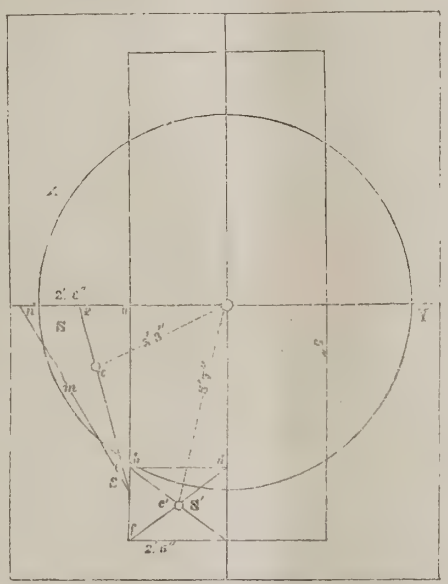
Fig. 8.



packing rings to make the steam-tight joint, thereby dispensing with scraping the surfaces.

Figs. 10 and 11 are a section and plan respectively of a valve as

Fig. 9.

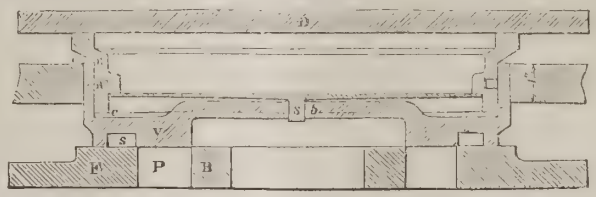


applied by Mr. Wheatley of the North British and Mr. Stirling of the Glasgow and South-Western Railways to inside cylinders; also by Mr. J. R. Napier to the boats recently designed by him for the Godavery River, for the Government, and manufactured by Randolph, Elder, & Co. at Govan; where F is the cylinder face, P the admission port, B the bar, V the valve, with a bar, *b*, cast on it to support the spring, S′; R the ring proper, with one of Ramsbottom's rings, R′, inserted; C C′, clearance to allow the valve to come back from the face (should water be in the cylinder, or should the compression rise higher than the steam in the chest by 1 lb., then the valve would leave the cylinder face and let the surplus pressure escape into the chest; so that there is no chance of water breaking a cylinder cover, and marine engineers may by the application of this valve dispense entirely with cylinder relief valves); S, a recess in the lap of the valve, which is filled when over the extreme bar on the one side and when over the port on the other, and which maintains the film on the bar, F, when working higher grades of expansion; but it never exhausts. D is the division plate for inside cylinders, and the steam-chest door of outside cylinders.

Fig. 12 is a section of a valve as applied by Mr. Cowan of the Great North of Scotland and Mr. Conner of the Caledonian Railways, where the exhaust cavity is maintained for the purpose of guiding the exhaust steam uniformly round the cavity, and insuring its free delivery into the exhaust pipe, but having two half inch holes through the exhaust cavity of the valve to let the exhaust pressure act equally on both sides of the cavity.

Where Mr. Conner uses a cast-iron valve he lines the cylindrical part

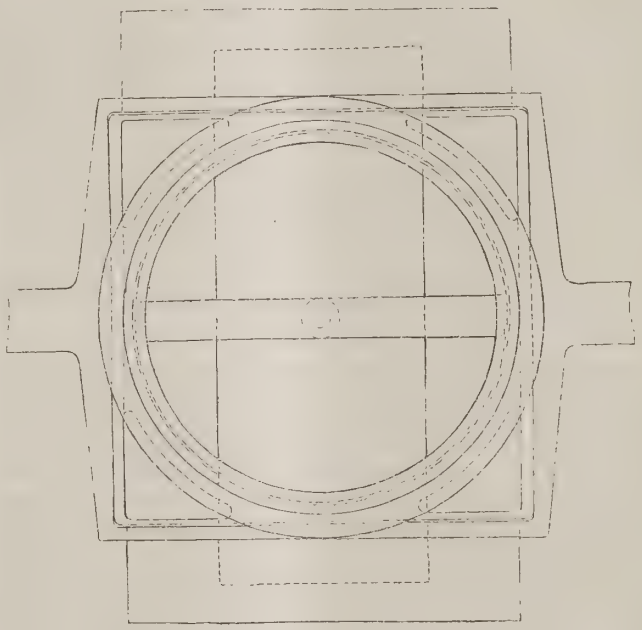
Fig. 10.



of the valve with a thin brass bush, to prevent corrosion when the engine is not working.

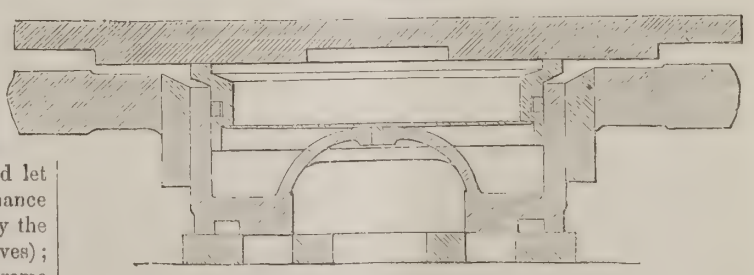
Figs. 10 and 11 also represent sections of the valve as applied by Mr. Stroudly of the Highland Railway to outside cylinders, except that in Mr. Stroudly's engines the steam exhausts out through the centre of the door, thereby dispensing with the exhaust port, which is always throttled

Fig. 11.



at the neck. But this arrangement also dispenses with four right-angled bends in the exhaust passage, between the admission port and the blast orifice; for whereas the ordinary exhaust passage has five bends containing 90° each, equal to a change in the free flow of the steam of 450°, by the method adopted by Mr. Stroudly, four of those bends are dis-

Fig. 12.



pensed with, and only one substituted; the exhaust steam flowing straight across from the admission port out through the centre of the door, takes one bend of 90°, and then proceeds straight up through the blast orifice. The result is the blast orifice can be enlarged without reducing the draught for combustion, accompanied by a reduction of 3 to 4 lbs. per square inch of mean back pressure on the piston. This is

indeed the best application to outside cylinders hitherto made, for the benefits are manifold, viz.:—A reduction of the weight of material of all the valve motion, implying also a reduced first cost in labour in getting it up, coupled with an almost entire abolition of cost of repairs to cylinder faces, valves, and valve gear; as well as the saving of power absorbed in working the valves and eccentrics, and a reduction of the mean back pressure on piston, and in marine engines the abolition of relief valves; to which may be added the total evasion of any chance of a break-down occurring to properly fitted valve gear.

[NOTE.—Without endorsing that part of Mr. Adams' paper wherein he persists to recognize a film of steam always existing between well fitted surfaces working in a gaseous fluid, we are quite prepared to believe that a layer of moisture from the steam adheres to and therefore lubricates the surfaces of contact when the valve is moving with the steam on, thus preventing metallic contact of the surfaces themselves, and accounting for in a great measure, over and above the diminished resistance to movement through the displacement of the steam, the delicate easiness with which Mr. Adams' valve is known to work. We do not say that the film is not a reality, but we should like to have it proved more conclusively than it appears to have yet been. In every other respect we fully endorse Mr. Adams' remarks, whilst adding, too, our testimony as to the mechanical beauty of all the arrangements adopted, producing the very highest results that can be expected from practice.

In the May part of this Journal we made mention of being promised the foregoing paper by Mr. Adams, and we should have published particulars of the Adams valve much earlier, but the author requested us to delay until he could give us a perfect *resumé* from his own pen; he having discovered that the journal in which appeared a portion of the paper read by him to the Society of Engineers published much that was imperfect and incorrect. Locomotive and marine engineers know what the results obtained mean, we need not add.—V. D.]

ON SOME POINTS OF PRACTICE IN IRON FOUNDING.

No. XVIII.

IN our last paper we considered at sufficient length what occurs in the cast iron itself in the process of "chill moulding." It remains now to treat of some questions which chiefly relate to the conditions and use of the chill moulds themselves in practice. At the conclusion of our last paper we recapitulated some of the most important of the conditions upon which the *depth* to which "*the chill*" can be carried; *i.e.*, those upon which the conversion of the external *couche* into white iron depends. Bearing still in mind that a casting made of "white cast iron," whatever be the nature of the mould, is not a "chilled" casting at all; that as in the case of the so-called Pallisser shot, which are made of such white iron, to call such "chilled projectiles" is an abuse of terms, and a particularly unwarrantable one, where, as in that instance, the verbal equivoque is made the basis of a claim for a public and undeserved reward; it becomes of some interest to the ironfounder to know to what *maximum depth* it may be practicable to carry "the chill" in castings made honestly of the best and most suitable quality of hard tough mottled cast iron, the best possible for chilling, but yet not "white pig or scrap iron," such as that obtained from melting up old grape shot or other cannon balls of equally hard material. No answer of an absolute character can be given to the question without taking into consideration the size or volume of the casting made, in relation to its surface exposed to the chill. With a thin casting, exposing a relatively large surface, it is possible to convert it all into chilled iron, except, perhaps, a thin line of gray spots about the central parts. But such examples are of little practical interest. It is otherwise, however, when the question refers to castings for known purposes, and in forms and sizes habitually required to be effectively chilled; as, for example, the cylindrical rollers for rolling boiler plate or sheet iron, the top faces of solid cast points and crossings for railway use, and the like. In all these it is important that the iron founder should *know* to what depth in from the surface he can, by the exercise of his best skill, carry the "chilling," so that he may not undertake an impossible depth if ordered, and may be in a position also to regulate the conditions of his moulding and pouring, so that he may *not* chill to a greater depth than may be requisite for the special purpose of the work undertaken, and so may leave as large a volume as possible of tough unaltered iron below the chilled skin, to resist the strains, transverse or otherwise, to which the piece is to be exposed; for it must be always remembered that the main structural value of the chilled *couche* is mere hardness and resistance to abrasion, that of the interior, toughness and tensile and compressive resistance to the action of extraneous forces combined.

For the vast majority of practical ends to which chilled castings are applied, chilling to the depth of an inch or so is more than sufficient—wear and tear is far within that limit as to depth before the piece becomes useless by mere reduction of volume or change of form—and there are very many uses to which chilling is applicable in which every end is fulfilled by a chill reaching to half that depth. But the case is otherwise where the hard chilled surface is subject to rapid degradation and wear, as in the case of the cylindrical "crushing rolls" employed for reducing to fragments hard ores or other minerals, or where the surface may require to be turned over and over again, or even to be cut into somewhat deeply in the lathe, as in the instance of rolls for rolling plate or other wrought iron. In such cases, the greater the depth to which the chilling can be carried the better, at least in the body of the rolls; for with rolls of any ordinary diameter, there must always remain abundance of unaltered iron about the centre or cone part of the cylindrical castings to satisfy the requirements of strength. In very *large* rolls, too, the necks are of so large a diameter that there need be no limitation there either; but in chill castings of rolls of small diameter, it may often prove the best and safest practice to cast the necks with a *thinner couche* of chilled material than the body. That may be done either by having the chill mould in three pieces, with much greater mass in the central or body chill than in those for the necks, or by casting the ends and necks of the roll not in iron moulds at all, but in moulds of dry sand or of loam properly attached to and forming part of the general mould, along with the iron "chill" for the central portion.

In this, as in all like cases, the *judgment* and experience of the iron founder must be his guide; only let these be based on clear notions of the conditions which rule his performances, as clear as his reception of the conditions as to "the job" itself which his customer wishes fulfilled. We may guide him to some approximate limits, however, before we go to these conditions themselves.

There are no cast irons, fit for use for chill casting at all, in which a depth of chill of at least one inch may not be obtained by suitable arrangements; but there are many "makes" of cast iron produced in various parts of the world by which chilling to a greater depth than that or thereabouts is practicable — the pig or scrap iron being always assumed as *tough bright gray finely-crystalline mottled iron.* Of course, if the founder has not this at his command, his only resource is to make use of white refining pig, or white hardest scrap cast iron, and melt these up in suitable proportion with his soft dark gray iron, that alone can scarcely be chilled at all.

The Swedes and Germans generally possess the finest qualities of mottled pig irons for chilling that can be found, and hence it is to chilled castings as made in the best foundries for such in these countries that we may look for instances of the best examples of deep chilling that can be found. The foundry of Herr Gruson, of Magdeburg, is an example of such. The pig iron that he employs is from his own neighbourhood, and is such that an inch square bar, cast in dry sand, placed horizontally upon supports 3 feet apart, will sustain without fracture from 1200 to 1400 lbs. transverse strain at the centre, and will deflect at that load as much as from $\frac{5}{8}$ to $\frac{7}{8}$ of an inch (versed sine), and on being relieved perfectly recover its rectilinearity. With such material, and proper tools in the way of chills, &c., a chill of 2 inches in depth *can* be made from the face of railway crossings, though a much smaller one is adopted in his practice. The greatest depth of true chilling that we have ever seen was in a broken-across Swedish iron roll, in which the chilled *couche* was to a depth from the surface of $3\frac{1}{2}$ inches, pure unbroken white radially crystalline chilled iron, with about 2 inches inside this of white crystalline iron, mixed with more or less scattered fragments of unaltered bright and very light-coloured mottled iron, being a total of chilled effect of about 5 inches upon a roll of about 2 feet 9 inches diameter of body, but a workable depth of chill for turning off in new facing this plate roll of not more than 3 inches; so that, in fact, the roller might wear in use to 2 feet 3 inches diameter before being cast aside.

The necks of this roll were chilled all through, and of absolutely white iron. The chill it had been cast in we were informed was about 14 inches thickness. There exists at the moment we write (June,

1867), in the Exhibition at Paris, a broken neck of an iron roll from one of the German states, presenting chilled characters almost as remarkable. The neck is about 15 inches diameter, and is chilled very finely and uniformly to a depth all round of about one-third its total diameter. Such are about the extreme limits possible in practice; the conditions producing this limitation we shall now point out. Inasmuch as the action of the chill mould is simply due to cooling the *external portion* of the mass of liquid cast iron poured into it with extreme rapidity, by reason of the rapid conductivity and large capacity for heat of the material (the cast iron of the chill), so *the mass* of the material in the chill is one of the most important considerations in fixing its powers in relation to the casting to be made; given the form and weight of the casting, and hence the relation between its mass and its surface.

To use language only commendable by its clearness in this instance—the *amount of cold* locked up in the chill must be such that it shall be competent to reduce the exterior *couche* of the casting to a *solid* state from its liquid condition, within a very few minutes in time from the mould being filled with metal; and it must comprise as much residual stock of cold besides as shall prevent this solidified external *couche* from becoming again liquefied by the heat from the interior and still liquid central part or core of the casting, transmitted more slowly outwards through the chilled *couche*, prior to the entire casting becoming solidified. The whole chilling process is an affair of a very few minutes from the instant of filling the mould; during those few minutes the exterior of the chill (we are referring now to a casting of some magnitude, say a large iron mill roll) becomes so hot that we dare not touch it, and currents of heated air evect a considerable amount of heat from its outer surfaces.

The amount of heat thus carried off during the time that precedes the solidification of the chilled *couche*, is so small in relation to the total heat of liquidity of the iron in the mould, and in the chill and their adjuncts, that we may neglect it, and view the liquid iron as robbed, in the first instance, of all the heat necessary to the process, by conduction into the mass of the chill only.

Let m = the weight of the chill.
M = the weight of the casting.
t = the temperature of the chill at the moment of "pouring."
t_c = the temperature of the fluid iron when "poured."
T = the common temperature of the chill and casting on the assumption above made, and when momentary equilibrium has been established.

C and C_c = the respective specific heats of the chill and of the liquid iron, at the temperatures t and t_c. Then on well-known principles,

$$(m\,C + M\,C_c)\,T = m\,C\,t + M\,C_c\,t_c \quad . \quad . \quad . \quad . \quad (1),$$

and

$$T = \frac{m\,C\,t + M\,C_c\,t_c}{m\,C + M\,C_c} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

The experiments of Dulong and Petit upon the specific heat of *wrought* iron at various temperatures, and calculations based thereon, gave the following results:—

Temperature	32° to 212° Fahr.	sp. heat	= 0·1098.
	212° to 662° "	" "	= 0·1255.
	at red heat	" "	= 0·1403.
	in fusion	" "	= 0·3282.

The latter figures are subject to much doubt, however, being like the last preceding, merely derived from the expansion of a series.

No corresponding experiments have ever been made upon *cast* iron, that we are aware of; but for our purposes we may adopt these as the specific heat for cast iron also, at the lower ranges of temperature. We may also assume the temperature of fusion of cast iron = 2300° Fahr., and hence take

$$t_c = 2300°,$$

or because the iron in chill casting always requires to be poured *hot*, for reasons yet to be adverted to, $t_c = 2500°$.

$C = 0{\cdot}1098$, $C_c = 0{\cdot}3000$, which if in error, is so on the safe side, as regards the *total* amount of heat to be carried off.

The function of the chill, however, is, as has been said, to carry off rapidly as much heat as shall bring the external *couche* of the casting to the solid state, *i.e.*, to say a temperature of about 1000° Fahr., or to a bright red in day-light, at which temperature and for a range of some extent below it, down to cherry red, cast iron is crystalline and *crumbly*.

But we must also have the residual stock of cold to preclude re-liquefaction of the exterior *couche* by the heat of liquidity in surplus in the interior. This will be met if we provide sufficient cooling power in the chill to bring the *entire mass* of the casting to 1000° Fahr., or, allowing a little margin for excess of temperature at which the liquid iron may be poured, to say 800° Fahr., or to about the temperature of melted zinc. Applying the preceding co-efficients, we have

$$\frac{0{\cdot}1098\,m\,t + 0{\cdot}3\,M\,t_c}{0{\cdot}1098\,m\,t + 0{\cdot}3\,M} = T = 800;$$

for our practical purpose it will be sufficiently exact to consider

$$C = C_c$$

and to write

$$\frac{m\,t + M\,t_c}{m + M} = T,$$

or taking the temperature of the chill in British climates as generally (if used *cold but dry*) at 75° Fahr., we have

$$\frac{75\,m + 2500\,M}{m + M} = T = 800°.$$

From which, as M, the weight of the casting, is always given, we readily find m = the *minimum weight of the chill* that shall be competent to effect chilling. As the mere practical moulder sometimes makes sad blunders as to the mass of cast iron he puts into his chills, when guided merely by eye or tact, it may be useful to know that any chill whose mass in relation to that of the casting to be made in it, is less than the above, must fail through deficiency in heat-absorbing power.

It would be very unwise in practice, however, to fix the above *minimum* as that for the weight of the chill, and for several reasons.

First, A chill, unless *rigidly free from moisture* internally, becomes extremely dangerous in use. When in the act of pouring, a volume of vapour evolved that would be absolutely harmless in a green or dry sand, or even loam mould, may not only spoil the casting but produce fatal accidents. The vapour is, so to say, here hermetically *pent* up; and it is heated up to a temperature that brings its tension almost instantly up to something like that of fired gunpowder. Experience of this has made the "chill caster" most warily full of precaution in guarding against moisture. To insure the absence of this, it is absolutely necessary that the chill itself should be warmed, and considerably above the atmospheric temperature at the time and place of casting; and the custom is with most moulders to run their chills into "the stove," or by other means heat them up to a temperature even higher than this. In fact, it is not uncommon to find moulders who prefer to employ their chills so hot that they cannot be touched by the hand; perhaps 250°, or even more, Fahr. It frequently occurs that the entire mould is closed, partly by green sand "box parts," or dry sand or loam, adapted to portions of the chill, viz., to form parts of the casting not intended to be chilled.

Now, if a cold chill, *i.e.*, one at or possibly rather below the temperature of the air of the interior of the foundry, have a greensand part so applied to it, or a not very carefully dried dry sand or loam part, moisture evolved from these must *condense* upon the interior surface of the chill, as in the worm or refrigeratory of a still. Nay, in any case, if a cold chill from the open air be brought into the warm damp air of the foundry, moisture will condense upon it for the like reasons, derived from the atmosphere alone.

Knowing these as facts, moulders always heat their chills. We have met with many able and experienced moulders who have assured us, as the result of their own observations, that the same chill mould, with the same fluid cast iron, and other conditions all alike, produces a better chill if the chill mould be heated to about 300° Fahr., or so, than when employed as cold as safety will permit. This, at first sight, would seem to be an anomaly, and in total conflict with the facts upon which the theory of the chilling process reposes. It may not be so, however; and we are disposed to believe that in this instance the observation of the keen-eyed working man, as in a good many other cases, will be found correct, and to rest on sound theory when rightly interpreted.

We have seen above that the specific heat of iron is greater as its temperature is higher; or, what is the same thing, the relatively colder

of two masses of iron will absorb heat more rapidly from the hotter mass as its own temperature is higher, the *difference* in temperature between the two masses remaining constant or nearly so. The warm chill, therefore, may be expected to carry off heat—where there is such a difference between the liquid iron and the chill as 2500°—300° = 2200°—better than were it quite cold; how much better, data are wholly wanting to enable us to estimate. However, from these combined reasons, the temperature of the chill may be taken, not at 75°, or below it, but at, let us say, 300° Fahr.; and as we make no supposition as to the value of increased capacity for heat at this temperature, the change of co-efficient will add to the minimum value of m. There are still other grounds for further augmenting the mass of the chill. The whole mass does not get perfectly uniformly heated, although the conduction of heat from the interior surface in contact with the liquid iron is so rapid that the exterior of a chill of many inches thick almost instantly becomes so hot as to make water thrown against it hiss off into steam; and even with very massive castings (and not too much mass of chill), to become within a few minutes luminous slightly in the dark; yet the interior next the iron is heated vastly more than the outside: heat, in fact, *accumulates* for a time in the internal *couches* of the chill, as the equation of Despretz,

$$y = \mathrm{A}\, e^{x - \sqrt{\frac{2h}{kt}}}$$

(see Peclet, "Physique," vol. i., p. 260) though not strictly applicable, proves. Now we must not venture to permit this to have even a chance of reaching such a high temperature as may risk the soldering together partially of the surfaces of the chill and of the casting, by which both may be destroyed. Such soldering may occur at a temperature far below that of actual fusion of the cast iron, under the circumstances in which here the surfaces of the at first liquid metal and of the chill are brought into and kept in contact. But the only way to be certain of avoiding this is to augment the mass of the chill, so as to get a larger and more rapidly heat-absorbent volume.

Upon the whole, for castings of moderate volume in relation to surface, and not of enormous absolute bulk, our own practice would suggest for the mean mass of the chill about

$$m = 3\,\mathrm{M},$$

or three times the weight of the casting to be made in it.

Economic considerations, especially in a large foundry largely occupied with chill castings of very various sizes, would influence us to employ no more iron in each chill than is indispensable; for the mass of inert capital that soon gets locked up in the iron of heavy chills is a consideration. But other and wholly different conditions fix a limit to the mass of the chill that can be employed for any given casting; in other words, to the thickness that we can safely give to the chill, having a given form and volume of cavity.

If we make the chill thick beyond a certain amount, of which experience almost is the sole judge, it is nearly certain to split, either almost immediately after the liquid iron has been poured in, or during the progress of consolidation of the casting. This arises from the fact already stated, that the interior *couches* of the chill are heated faster and more than the outside. These interior portions by their expansion exercise a bursting strain upon the exterior parts, quite analogous to those produced in a gun heated by rapid firing, and the direct converse of the strengthening of guns by construction in rings superposed and shrunk on with initial tension. More or less of this occurs inevitably in every chill; but the bursting strain is greater as the thickness is so. The other conditions being the same, and as the absolute size of the chill (its diameter, let us suppose, if a cylindric roll chill) is greater, as soon as ever the internal strain exceeds the elastic limit of the colder portions of the outer iron, the chill is liable to burst. Large chills, as a measure of precaution, are very frequently hooped with wrought iron shrunk on upon them externally, when first made, and the precaution is a prudent one; for, though we have known even such hooped chills burst, the liability is greatly diminished, and in any case it is far better to hoop at first than to let a large and valuable chill split first, and then hoop it. In this latter case, the form of the chill, if cylindrical or otherwise symmetric, is always more or less distorted, and never perfectly restored afterwards. Moreover, the wear upon the line of the crack or cracks on the interior surface, by the action of the fluid iron, is excessive, so that the chill for all the finer order of work becomes of inferior value, if not worn out. The sudden expansion in volume which there is some ground for assuming may take place at the moment of consolidation of liquid cast iron, may also not be without effect in tending to burst chills. Assuming such expansion to be established, however, it is not without interest to observe that its possible effect as a bursting agent will be much less in large chills than in very small ones; and for the same reasons that a *small* water pipe which freezes in winter into a solid plug of ice at once, is more certainly burst than a large water butt or pipe, which gets an interior coating of ice several inches thick formed interiorly all around its exposed sides, but leaving a core of liquid water still in the middle. The water and the interior of both large and small pipes are in constant contact, just as the liquid or partly solidified iron is in constant contact with the interior walls of the chill; but the consolidation in the large chill goes on by accretion, layer by layer, and the total effort at any instant can never be great. It is otherwise in the small chill, in which the whole volume consolidates nearly at once, and the expansion is that due to the entire volume so simultaneously solidified.

THE PARIS EXHIBITION.

In the present article we propose to string together some notices of various miscellaneous objects that have attracted our attention in going over the great Exhibition on the Champ de Mars.

SPIRAL BIT FOR WOOD WORK.

M. E. Hamelle, of St. Quentin, exhibits a spiral bit for use in cabinet-making, carpentry, and wheelwrights' work, and in the construction of framing for wagons, ships, &c. This bit is said to be capable of executing the most difficult curves required in shipbuilding, rebates, planing, grooves, and mortises, at the rate of from 4½ feet to 6 feet per minute, according to the motion applied to the wood required to be worked. The mortises are ready for use as soon as the tool is withdrawn. The bit is of cast steel, and of great strength, so as to be capable of working upon the hardest wood. It is composed of two helical gouges hollowed out inside, and whose extremities form two cutters in opposite directions, slightly circular in form, and separated by a groove. The external edges of the gouges form cutting edges, and the thread of the helix, which is variable along the length of the cutting part of the tool, is so arranged that the whole length of the bit may enter into the wood without becoming heated, and without the necessity of withdrawing it to clear out the shavings. M. Hamelle exhibits in Class 54 a large collection of bits of different dimensions made by him, and shows them in operation. Among them there is a bit of immense size (2 feet 8 inches long by 11 inches in diameter), intended for the working of wood used in shipbuilding. Such a tool will in many cases diminish considerably the amount of handwork; such, for instance, as in the carcasses of ships, where the work hitherto has been effected but slowly by hand.

FILTERING APPARATUS.

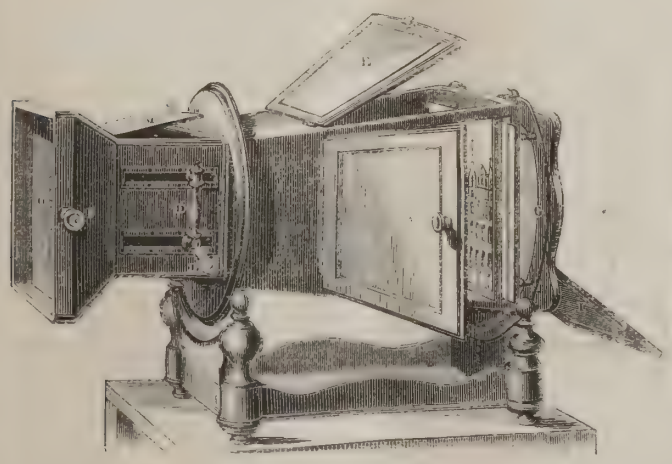
In Group 6, Class 65, M. Bourgeoise exhibits an apparatus for filtering water on a large scale. The water is introduced along a culvert into a receptacle, separated by a stone wall or partition from the receptacle which contains the filters, but communicating with the same by means of openings at the bottom of the partition. The filters consist of any required number of tanks of wood or galvanized sheet iron, which are supported by cross beams imbedded in the walls, the joints being hermetically closed by the aid of caoutchouc, leather, or felt, so as to prevent any leakage of unfiltered water. The bottoms of these tanks are formed of wirecloth, upon which the filtering media are placed; another layer of metallic cloth being laid upon the latter. The water, which enters the receptacle situate underneath the filters, being in communication with that in the reservoir and culvert, passes, in seeking to attain the same level, through the filtering bed, and the clear water runs off through an orifice placed lower than that of the culvert, and, like the latter, provided with a sluice which serves for the cleansing of the filtering media, as explained below. After the apparatus has been at work a certain time, the filtering media require of course to be cleansed. This operation is effected in a simple manner, and without removing any of the parts, by closing the outlet, and admitting the water from the culvert into the space above the filter until it is filled, then closing the inlet and opening the sluice placed at the bottom of the receptacle beneath the filters. The water rapidly descends through

the filtering media, freeing them from their impurities, and finally escaping through the sluice. This simple operation is sufficient to purify almost entirely the filtering media, and their removal will not be required more than once or twice a year in order to submit them to a thorough cleansing. M. Bourgeoise exhibits also an apparatus intended to be used in private houses, hospitals, colleges, barracks, or in establishments which require a certain quantity of filtered water, such as manufactories of aerated water, paper mills, &c. The diameter of the apparatus may vary from 10 inches to 3 feet; and it produces, according to its dimensions, from 20 to 900 gallons of filtered water per hour. It is composed of a thick metal casing of a cylindrical form, provided with a convex bottom. To the top a convex cover is bolted, and thus a receptacle for the filtered water is formed. The bottom part serves as a reservoir for the water requiring to be filtered, and its upper side is formed of a layer of very strong wire gauze. The water, impelled by its pressure, passes through this wire gauze, and a thick bed of prepared and closely-packed sponge, and is deprived of the coarser of the extraneous matters which it contains. It is also freed from colour, taste, or smell, and loses all trace of sulphate of lead or zinc, with which it may have been contaminated in passing through the supply pipes. The purification is completed by the water passing through a felt filter situate at the top of the apparatus, and which is rendered antiseptic by a special preparation. This apparatus acts as follows:—The water is introduced through a pipe provided with a cock, which being closed, the water has no other passage but through a branch, which conveys it into the lower reservoir, whence it percolates upwards through the bed of filtering media, and enters in a perfectly filtered state the receptacle at the top. In order to clean the filtering media, the cock is turned so that the water arriving from the supply may be compelled to pass through another branch pipe, which conducts it to the top of the filter, whence it descends, passing through the filtering media, and carrying with it all the impurities they contain, which escape by a lower discharge cock. The advantage of this arrangement is, that the filter will work well for a year without the necessity of withdrawing the filtering media in order to cleanse them more perfectly. M Bourgeoise also makes several forms of apparatus intended for domestic purposes.

THE MEGALETHOSCOPE.

The Megalethoscope (so named from two Greek words signifying to magnify) is a magnifying optical instrument invented by C. Ponti, optician and photographer, and is nothing more than the Aletoscope of the same inventor in an improved form. The improvements are three in number, viz.:—1, The two lenses, which may be removed through the small door, M (fig. 1), for the purpose of cleaning them, instead of

Fig. 1.



one fixed lens; 2, the substitution of several diaphragms, opening on a hinge (figs. 2 and 3) so as to inclose large and medium sized photographic views and cartes de visite, for the single diaphragm used in the Aletoscope; 3, the method of fixing ordinary portraits and small photographic views. By these improvements the magnifying of the views is considerably increased; the relief is more developed, but without exaggeration; the defects of sphericity are reduced to a minimum; greater clearness is obtained; and by the inclosing of the views in a frame, the eye is prevented from wandering to the margin at the expense of the stereoscopic effect. Each view is so disposed that it may be seen by reflection or as a transparency, and by day or by artificial light. The instrument is first placed on a table in front of a window, and the photographic view is introduced through the aperture, C (fig. 1); if it be desired to view the object by reflected light, the two reflectors, A, B, are opened so as to throw light on the same, but if by transmitted light, the reflectors are closed, the door, I, opened, and the light at the middle of the aperture passes through the back of the photographic view. Its effects are more striking with artificial light; and a gas burner or petroleum lamp answers the purpose very well. The observer places himself before the eye-glass, O, of the apparatus (fig. 1), moves forward or draws back the lens, by means of the two lateral handles, D, to suit his sight; and according as the photographic view is required to be on

Fig. 2.

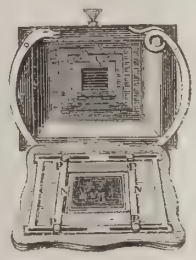
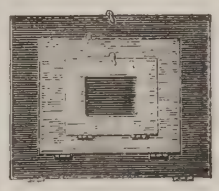


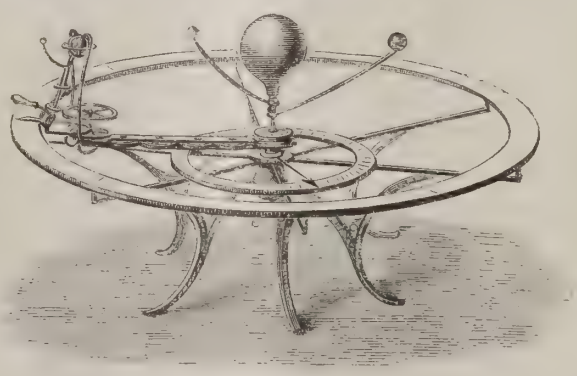
Fig. 3.



the wide or narrow side, the instrument (fig. 1) is turned a quarter turn from right to left by means of the buttons, F, F, which carry upwards, or to the right, the notch, C, intended to receive the photographs. In order to prevent the eyes from being strained by the excess of light at the time the transparent views are changed a rough glass is placed between the two lenses when there is no photograph between the eye and the lamp. Two flat bars, N, N (fig. 2), sliding in a groove on the internal frame of the door, I, are provided, which adjust themselves to the size of the smaller views, such as portraits, &c., and are secured by the four screws, P, P, P, P. The size of the diaphragms used should also be proportionate to that of the photographs to be viewed.

BARLOW'S PLANETARIUM.

An ingenious planetarium, exhibited by the inventor, Mr. M. Barlow, of Lexington, Kentucky, seems likely to be of great service in schools and colleges by aiding students in making themselves acquainted with the physical laws of astronomy. This planetarium (see annexed engraving), which is put in motion by a winch handle, shows the relative position and motions of the earth, moon, and inferior planets for every second, the different phenomena of the conjunctions, transits, eclipses, &c.,

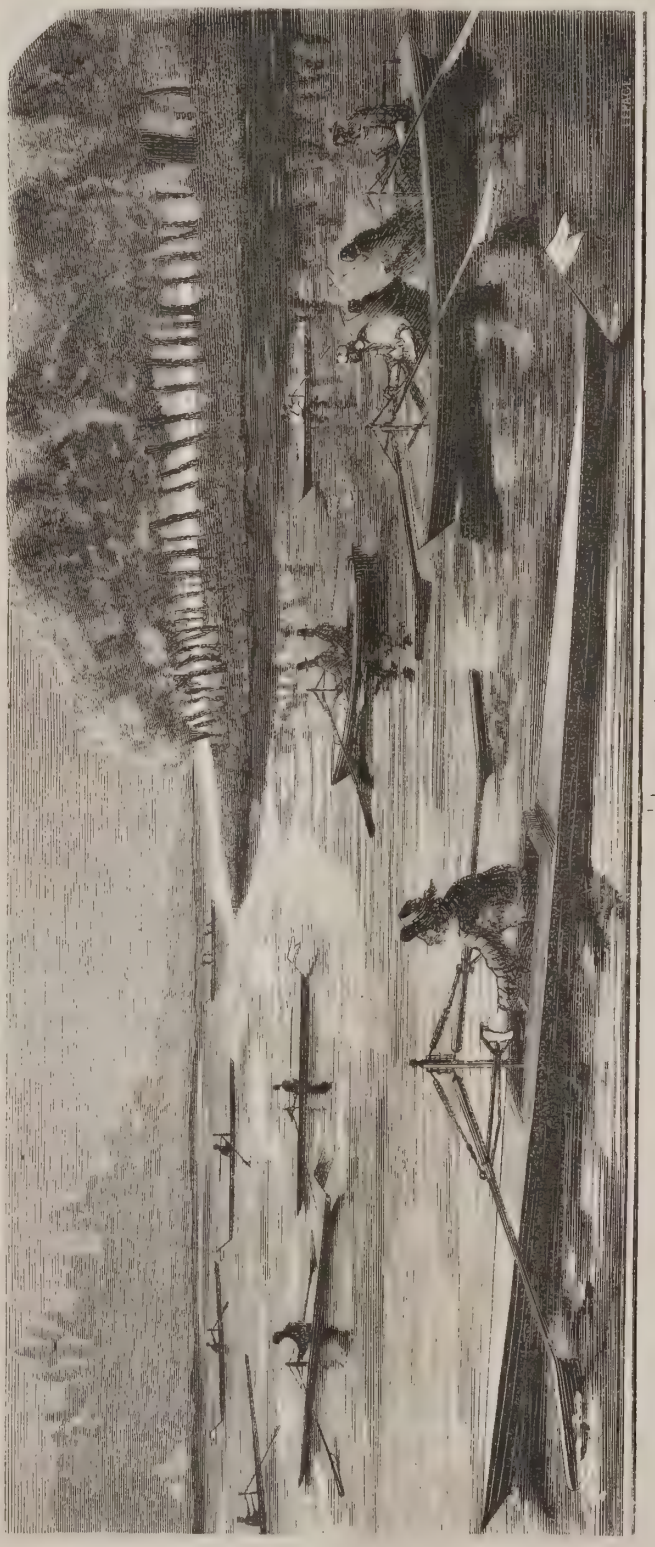


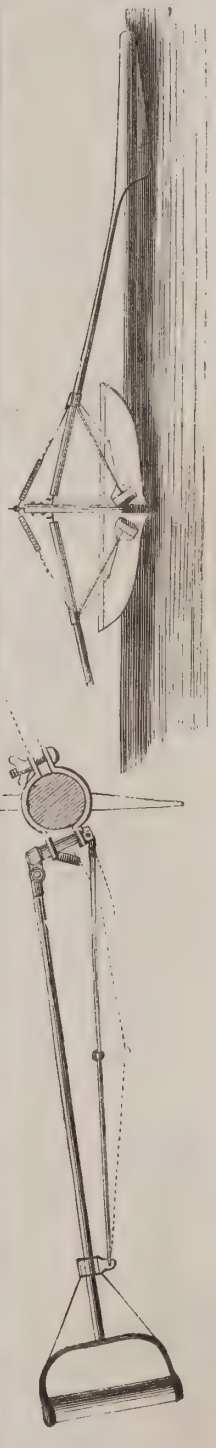
and, by means of its hand-pointer and dial, indicates the periods of their occurrence, whether past or future, with extraordinary precision; it also shows clearly the nodes and phases of the moon, the inclination and eccentricity of its orbit, and the same of Venus and Mercury.

The sphere representing the earth is covered with a chart of the two continents, and is surrounded by a meridian and an equator, which always maintain their relative position to the sun. The instructor is thus enabled to explain clearly the change of season, the variations in length of day and night in different latitudes and seasons, and other astronomical phenomena.

A NOVEL PLEASURE BOAT.

M. E. D. Farcot, of Neuilly (Seine), exhibits an arrangement shown in the annexed cut, with a view to remedy the inconveniences attendant upon rowing with the back turned in the direction of the boat's course, and to substitute for the ordinary method of working the oars, which is both difficult to learn and fatiguing when learned, a simple contrivance by which the operation may be performed with ease and facility. The ordinary oar acts on the principle of a lever of the second order; that is to say, the resistance represented by the boat is near the centre of the lever, which is represented by the oar, and the rower, or the power, acts at one end of the lever, whilst the water or point of support is at the other end. M. Farcot's apparatus is a lever of the third order; that is to say, the rower acts on a point of the oar situate between the points of resistance and support. This arrangement possesses a double advantage—viz., first, a reduction of the length of the oar for a given arc, the centre of oscillation being at the end of the oar instead of a certain distance along its length, as in the ordinary system; and second, the operating directly upon the oar instead of indirectly by the reverse motion, which distributes the force instead of accumulating it at one point. The oars, moreover, may be of lighter construction.





In this apparatus the oars are maintained in equilibrium by helical springs, which hold them suspended almost horizontally above the surface of the water, and the springs are secured to a short mast erected in the centre of the boat, which acts as a point of support to the oars. The end of the handle of each oar is provided with a copper socket, closed at its end to receive an axis made of hardened aluminium bronze (which metal possesses the advantages of hardness and non-liability to oxidation), secured to the mast by a double joint, and serving as a pivot to the oar, on which it may turn in any direction. A copper collar, provided with a thumb screw, is fitted on to the round handle of the oar, for the purpose of adjusting the position of the oar in the water; it carries a hook, which being attached to a bar connected with the suspension springs, when the collar is moved along the handle of the oar the springs are extended, and the handle maintained at a height of some inches above the surface of the water when left to itself. There is also another light and rigid rod attached by a double horizontal joint to the collar of each oar, one end of which the rower holds in his hand, and by means of which he actuates the oars. A copper chain of two links, suspended at one end from the collar, whilst its other end is connected near to the handle of the rod, limits the length of the arc described by the oar when being drawn towards the rower, and a copper frame also fixed on to the collar limits its motion in the opposite direction. If the handle of the oar be properly adjusted in the collar, the blade will be at such an angle as to offer the greatest resistance to the water, whilst on being elevated it will be "feathered" or presented to the air in such a way as to offer the least resistance to the wind. The oars are placed in the position in which a skilful rower would hold oars of the ordinary construction, and the manœuvring of the apparatus is easily acquired after a few hours' practice, so as to accustom the rower to work the oars facing, instead of with his back to, the direction of the course of the boat. It offers peculiar facilities where there is but one rower without a coxswain, but there is ample room for two rowers on one seat, a width of about 3 feet being sufficient with this apparatus for each to work an oar without inconvenience.

The total weight of the apparatus is not more than from 9 to 12 lbs., and that of the two oars about 4½ lbs., and its entire cost need not exceed £4.

MARINE SALVAGE BUOYS.

Amongst the numerous appliances for saving life and property at sea exhibited at Paris, there are some marine salvage buoys invented by M. Buisson des Leszes, and recently patented in this country. The inventor proposes to provide on board every vessel a buoy made of sheet iron, and of sufficient capacity to serve as a safe for containing jewels, specie, valuable papers, &c., which will float on the sea, and retain its valuable contents in the event of a disaster occurring involving the loss of the ship.

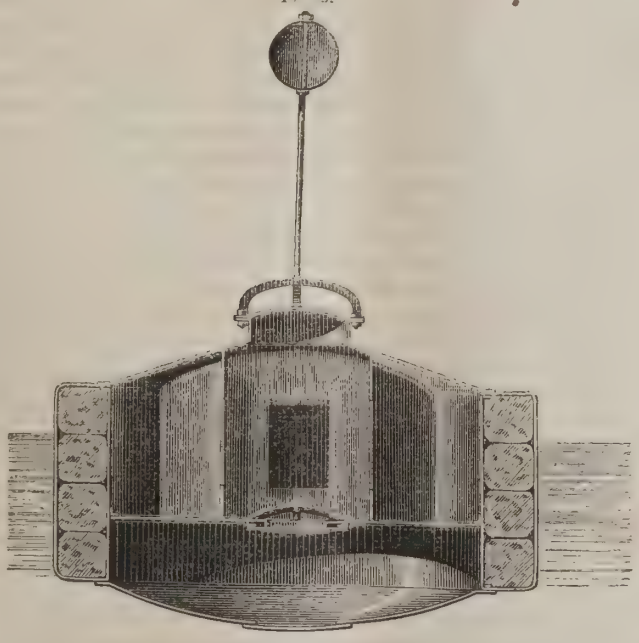
The essential condition of an apparatus of this kind is to maintain the buoy floating on the water against all accidents arising from defects of construction, or the shocks to which it might be exposed by striking against rocks, and various materials may be used which will answer this purpose; for instance, they may be composed wholly of metal, or of

Fig. 1

metal and cork combined, or entirely of cork, according to the description of articles they are required to contain.

The great weight of the valuables often on board would require that the buoy should be of considerable strength; besides which, it would have to be sufficiently large to be readily seen at a distance, and not be

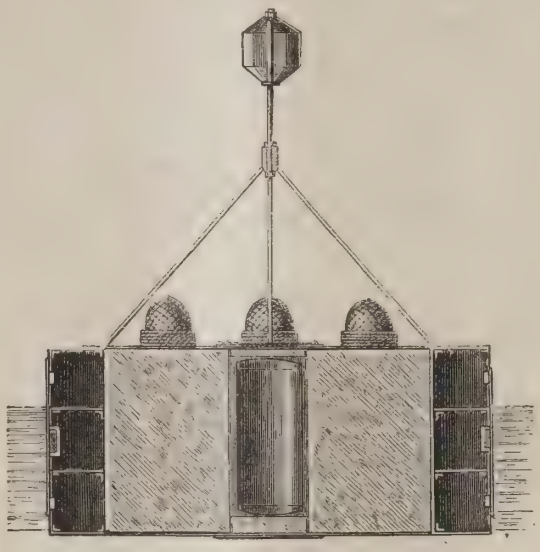
Fig. 2.



mistaken for one of the floating waifs occasionally met with by the mariner. On the other hand, from the great density of the precious metals, and the small space occupied by jewels, cheques, &c., compared to their value, a large portion of the buoy would be unoccupied, and it may be filled up by air-tight partitions in the case of metal buoys, and for other kinds by cork, or similar material of less specific gravity than water. Care has been taken in designing these buoys to avoid any projections, which, if the buoy were abandoned to the sea, might become entangled in the rigging of the ship, and cause it to sink with it.

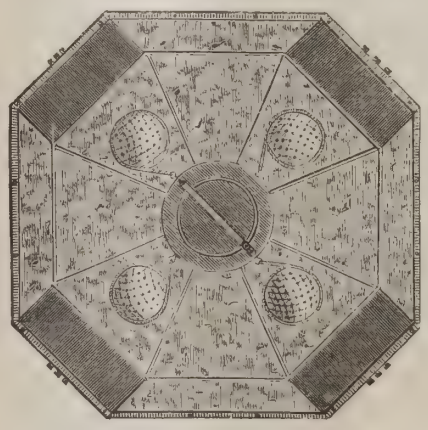
The buoy shown in elevation in fig. 1, and in vertical section in fig. 2, is constructed of sheet iron, surrounded with a cork zone, which is inclosed in galvanized iron, and secured by iron bars rivetted at the top and bottom corners. This zone, so inclosed and secured, is intended to protect the buoy from injury, and to augment its floating power. This buoy is about 9 feet in diameter inside by 4 feet 6 inches in height,

Fig. 3.



and is capable of sustaining a load of about 8 tons, representing more than £60,000 in silver, or £1,000,000 in gold; but the load should not be more than one half this weight to insure the flotation of the buoy in the event of the water getting into one or two of its compartments. The buoy is composed of six air-tight compartments; it is entered by a man-hole at the top, closed by a cover which is bolted on (an india-rubber washer being interposed), and carries a light ball, painted in brilliant colours, to attract the mariner's attention. Access is also obtained to the lower compartment intended for the specie, &c., by a

Fig. 4.



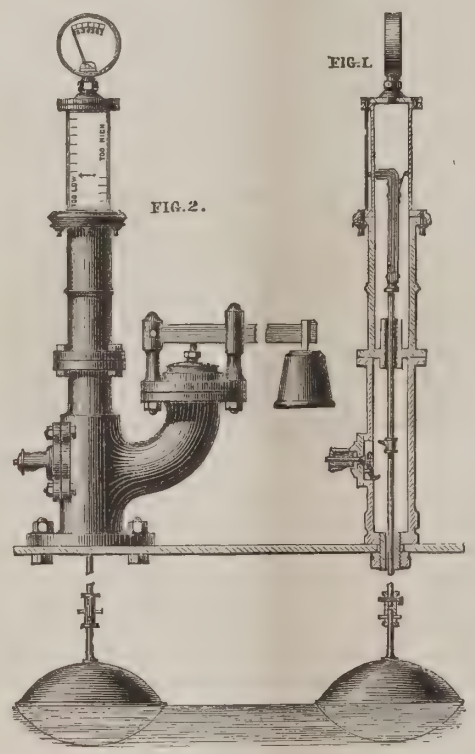
man-hole, the joint of which is effected by an india-rubber washer, and to the side compartments by metal doors, which are hermetically closed at the time of the departure of the ship by soldering.

Fig. 3 is a section, and fig. 4 a plan of a buoy slightly modified in construction. In this the buoyancy is effected by a cork block, inclosed in netting or galvanized iron wire, secured by iron braces. Four ordinary strong iron boxes are secured to the circumference by bolts to receive the cases of specie or bullion conveyed by the ship. In the centre a space is reserved for a cylindrical box perfectly air-tight, where papers that would be damaged by contact with sea water are deposited. Being surrounded with cork, it is proof against any shocks to which the

buoy might be subjected. In most cases the central box might remain in the captain's apartment until danger became imminent, and then be placed in the buoy.

MAGNETIC WATER-LEVEL INDICATOR FOR STEAM BOILERS.

This form of water-level indicator, shown in vertical section and side elevation at figs. 1 and 2 respectively, is the invention of M. Lethuillier-Pinel, of Rouen. It may be adapted to all kinds of boilers, and it varies in details according to the particular kind of boiler to which it is applied; but it essentially consists of a hollow metal float of a spheroidal shape, tested to ten atmospheres, and furnished with an iron rod or stem, terminated by a powerful magnet which rises and falls in a case of cast copper. Outside of this, and upon one of its faces, there is a needle, isolated from all mechanical support, and maintained



in its position solely by the attraction of the magnet, to which it serves as an armature, and which is capable of moving along the divisions of a graduated scale, the zero point of which corresponds to the normal level of the water in the boiler. The height of the water's level is always rendered visible, because the needle invariably follows its fluctuations. When the extreme limits of the course of the needle are reached, a pin or projection on the rod acts upon the lever of a whistle, and thus the want or superfluity of water is made known. The weight of the float, rod, and magnet each causes them to fall as the water sinks in the boiler, and thus brings the apparatus for sounding the alarm-whistle into play when the supply of water needs renewing. We are indebted to the *Propagation Industrielle* for several of the above illustrations.

PARIS EXHIBITION.

SOME OF THE MORE NOTABLE OBJECTS IN MACHINES FOR RAISING WATER AND IN MACHINE TOOLS.

FIRE-ENGINES—always an abundant display from London makers, who have been long stimulated and enriched by London fires—were not shown by the makers of other countries in a prominent way in 1862. At Paris, however, there are fire-engines from almost every important and from some second-rate powers exhibiting.

Amongst them all the only fire-engines actually tried have been the steam fire-engines of London makers, and one by a French maker upon an American model. These all were not far apart in merit; those of the two London makers were very closely abreast of each other, and the victory which has been adjudged to one on other grounds than mere performance, was, we think, distinctly and fairly won, and we were present at the trial.

There are manual fire-engines of considerable excellence shown by France, Prussia, Switzerland, Wirtemberg, Austria, Belgium, Russia, and Canada, and by other states also. Those from England maintain, so far as eye and judgment can decide without actual trial, their long held superiority—compact, strong, simple, well adapted to the muscular system, range of arm, and power of man. They leave little room for improvement, if we accept the British *type* as the best. France, however, seems to entertain different views from ourselves as to type of engine, and it may be that these differences have their origin in those of the construction of the buildings of the larger portion still of the cities and towns of France. These are lofty, often too lofty to be dealt with satisfactorily, even by our own powerful manual engines, from the ground level, as respects their top stories. They are also full of small, narrow, and deep interior courts, and of passages and staircases, crooked and devious. Our notion would be to carry hose through these; the French appear to have decided that a small class of engine, that can be carried by four or six *pompiers*, and all contained in a large copper rectangular round-cornered pan, is a better instrument. Not many years since the whole establishment of the *sapeurs pompiers* of Paris was supplied with engines thus constructed. At present, however, France presents also other engines more nearly upon our own type, and of much greater size and power. The main differences are in the whole of the working parts being left exposed, and supported but by naked iron or steel framing. The height of the handles and length of the stroke are not as well adapted to the human frame as in our own, and this remark applies still more to some of the large long-stroked engines from Canada and elsewhere.

The fire-engines by Kurtz, of Stuttgard, are extremely well finished, with a vast deal of showy work about them; but without some rattling hard work over rough pavement, and a tough bout or two of measured pumping with dirty water, it would be impossible to say whether or not they may be more showy than useful.

Some of the Austrian engines have neatly made sheet-iron cisterns, but with wooden upper works and wheels. This was pointed out as a novelty. The large fire-engines for the Dublin Police Fire Brigade were so constructed, however, quite fifteen years ago, and with wrought-iron suspension wheels also; in fact in those engines there was not one vestige of timber except the ash pole handles to which the men apply their hands. In all the foreign fire-engines, not even excepting the French, there are many points of detail more or less inferior to our British ones. The quality of the brass employed for couplings and joints, for instance, is far inferior to the tough hard red brass of good English makers, and many of the forms adapted to delivery pipes, elbows, joints of pipes, nose pipes, &c., are such as the hydrodynamic engineer must find fault with.

The water supply to the Exhibition itself, including the park and all that therein is, was fixed by the Commission of France as requiring 10,000 cubic metres per day, which at the rate of 100 litres a head, is equal to the supply of a town of 100,000 inhabitants. About one-half of this supply is delivered at high pressure, *i.e.*, with a head of from 20 to 25 metres; the other half with a head of not more than 5 or 6 metres above the highest surface level. The Commission decided that so great a daily demand had best be provided for in a way quite independent of the general supply to Paris. They therefore decided upon the construction of a reservoir containing 4000 cubic metres, to be established upon the top of the hill of the Trocadero, opposite the Pont de Jena end of the Champ de Mars, but at the other side of the river, near the Avenue Malakoff, at 32 metres above the floor of the Exhibition, and to pump into it from an engine house established close beside the Pont de Jena.

This is the source of the high service; the low service comes also from the river Seine, and is supplied by the pumps of the large marine engines from Indret, of 1000 horse-power, which can deliver 1200 cubic metres per hour, with the power, in case of necessity, of employing also the power of the engines of the Forges et Chantiers de l'Ocean Compagnie.

In case of these engines not being at work from any cause, five distinct pumping systems have been arranged in the park, under the responsibility of as many exhibiting engineers, who take up the water supply when called upon. One of these takes the water direct from

the Seine and delivers it into the small lake or pond at the upper part of the park; the others draw out of the lower basin's bed from the former, and supply the canals and waterfalls in the gardens, and so forth, in various parts of the park, and the boilers and condensing water for the engines. The head against which all these last work is regulated by a plate-iron cistern holding 55 cubic metres, and whose surface is 8 metres above the floor of the Exhibition. The high service supplies all the monumental fountains, some of which rise (without the jets) 30 to 35 feet above the ground, the fire cocks, and the watering of the floors and park. There are two perfectly distinct systems of mains, but the two are capable of being united at any moment, in case of accident by fire or any failure of supply in one or the other.

The chief undertakers for the pumping within the park are MM. Scott & Sagey, Letester, Neut et Dumont, Nillus, Coignard & Co., Thirion, and Rouffet. The pumps are mainly single-acting lifting pumps. Some of them, especially those of Thirion and of Nillus, are of considerable merit, and work smoothly and well. Coignard & Co. also work with two helicoidal centrifugal pumps, actuated by a locomobile. All these pumping engines will be found by the visitor not far from the great red iron lighthouse in the lower part of the French park. The lighthouse is a very noble work designed by M. de Reynaud, C.E., engineer-in-chief to the lighthouse department of the government of France, and is intended for New Caledonia.

In the British department, the death of Appold seems to have removed his pumps from their old pre-eminence of position, and the show for the ignorant million of a tremendous volume of water pumped up a few feet high, made the most of there by breaking up over an artificial rocky lip of plaster and brick, and then falling back again, thundering into the cistern whence it came, is now taken up by the Gwynne centrifugal pump, as to which beyond this there is little more to say. Close beside this stands at work Bastier's patent chain pump, one in which circular discs, armed with leather or vulcanized caoutchouc flanges pass (two at a time at least) through a bored vertical pipe, as the endless chain passing over its top sprocket wheel drags the necklace of discs along with water. Patent for this pump there can be none. The pumps fitted on board the *Royal George* when she was sunk at Spithead more than a hundred years ago, were constructed on this identical plan, which has been subsequently also proposed and reproduced. It may not be a very bad pump for moderate lifts, though even here in the Exhibition, the amount of power wasted in splashing the water about in the cistern out of which it works is pretty apparent; but to advise the employment of such pumps for very deep lifts, as for unwatering coal pits, is to ignore all judgment in mechanics.

Williamson's and the North Moor Foundry (Schiele's), centrifugal pumps are very near these; but these have been exhibited and commented on more than enough.

There are some curious helicoidal pumps on a small scale exhibited in the Park Annex of the Belgian department. One of the most remarkable, and at the same time promising centrifugal pumps, in the Exhibition, is that of W. D. Andrews Brothers, of New York, in the United States division. It takes in the water in the direct line of the suction pipe axis, gradually whirls it round, and appears to fulfil in a high degree the theoretic demands for the perfection of such pumps as are dependent on centrifugal action. But its available duty, or useful effect, who shall judge of? there is no means of determining it experimentally. Of what real use to mechanical science, we do earnestly again ask, are these vast exhibitions, if they are let to come and go, without even an attempt being made to decide on any of the real merits or demerits, in a rigid experimental manner (none other is worth anything), of the machinery shown? Mr. Gwynne will continue in the year 1868 to asseverate that he was immeasurably superior to Mr. Andrews, Mr. Andrews to affirm the same with regard to Mr. Gwynne and all comers: who is to decide? no one, for no one can, no one has got the authority and the means provided, and thus medals and rewards come to be delusions often, and public evils, instead of benefits.

Close to Andrews' centrifugal pump, is an American direct-acting steam double-acting force pump, with some peculiarities, and whose working appears very silent and good under heavy pressure. There are throughout the building pumps for water supply for domestic and like uses, for boiler supply and other uses, literally innumerable. Few of these, if any, present features either of much novelty or merit. There are in Sweden, however, from *Motala*, some boiler feed pumps for marine engines, or any engine boilers, of remarkably compact and elegant design, and of great beauty of execution. Sweden has not sent very much machinery to Paris, but what she has sent is all very choice, and highly creditable to that remote northern country of Europe, so little in connection with the remainder. There are some good centrifugal pumps in the Swiss Annex; and we ought to have mentioned in the proper place, that the centrifugal pumps of Neut et Dumont, which partly supply the Park, &c., and which draw through a horizontal suction pipe of 120 metres long, and deliver 800 cubic metres per hour, are worked by a wire telodynamic cable of Hirn's, from a point some hundreds of yards distant in the Park; that the wire cable is not much thicker than the pen handle wherewith we write, and yet at the pump end the power it transmits, when reduced in speed, is brought to the pump axis pulley by a leather strap of nearly 12 inches wide—is a very convincing proof of the reality of the power thus transmitted by Hirn's elegant invention. In one sense the Giffard injector may be deemed a pump. Many of these are exhibited with modifications and simplifications not hitherto adopted in England. Amongst these the injectors of Schaeffer of Magdeburg have this great advantage, that they are *always ready* to deliver water the instant the cock is turned to let on steam.

As regards the tools exhibited, it has been said continually, there is little or nothing new. In one sense no doubt this is true, but it was equally so in 1851, and will be so in 1900. So soon as the simple lathe (which, we may in passing remark, may be seen at work, in its most rude and primitive form, under the *foot*, or rather, toes and hands of the turner of ivory in the Egyptian Trades Annex in the park) had been once developed into the self-acting lathe, the planing machine, the slotting machine, and the shaping engine and drill, there was really an end of the possibility of any great further novelty in the construction of tools. We then possessed tools to form circles, straight lines, to bore holes, and to trace any curves (in a plane of single curvature) we desired. Improvements must therefore be in constructive details or proportions, and these are not wanting in many ways, countries, and places here, but to find these out is not for the million. To declare there is no improvement visible here in tools, is not much more than to declare oneself unfit to discern whether there be or not. The machine tools shown, if we look at them with a broad glance, and compare them with those of 1851–1862, show upon the whole, more or less improvement of the following characters—greater solidity and massiveness of construction, a clearer perception of the amount and direction of the forces they are called upon to resist, and a more philosophic adaptation of material and form to fulfil these conditions; greater simplicity and perfection in the forms of framing and supports; a more frequent and perfect adaptation of automatic movements; better application of material to each special structural part, whether passive or mobile; an advance towards so forming the parts of machine tools, that they shall be capable of being reproduced and finished by machine tools, that, so to say, tools shall *breed* tools. We have no hesitation in affirming that there are tools by several great makers of France, Belgium, Prussia, Switzerland, fully equal in design and execution to anything that Great Britain has yet produced, and we will not except even the tools of Whitworth, which are shown on the present occasion.

In point of gigantic size and power there is probably no tool exhibited more remarkable than the immense shearing, punching, and rivetting machine by Varrell, Elwell, and Poulot, with direct-acting steam power attached, which has been purchased by the French government for the port of L'Orient. The framing and the oscillating beam or lever are cast hollow, the castings themselves of admirable quality, and the designs and proportions good. We ourselves are always disposed, however, to object to multiplying the ends or uses of these great tools —they are too big and costly to waste time in changing tools at the working point; and they cannot, with any good workshop economy, be employed at once by two or more gangs of men with different objects, say, one punching and one shearing, in view. In all large tools the maxim should be *one tool, one use.*

Another very heavy tool is the great Belgian steam hammer, by Auguste Detombay, à Marcinelle. This makes a six-foot stroke, has a head of 5 tons or more (both by the eye only), a hollow framing standing on four great arch-formed (square, round-cornered in section) tubular legs or limbs, all cast in one with the bedplate, which is 9 feet × 18 feet, by about a foot deep—a really fine job.

De Bergue, in the British section, exhibits a very massive, upright, double-ended, direct-acting shears and punch, generally like the preceding one described. Also, in photograph, very heavy shears for

shearing the edges of large plates, combined with lever shears for bar iron, worked direct from steam-engine attached; not novel, but good in details, save the same objection of combining two objects in the one great tool.

Whitworth has a fine collection of his well-known tools, not different, except in one or two instances, from anterior known types. A lathe for turning simultaneously both ends of railway axles has more pretension to novelty, and much to claim for itself the award of excellence. The axle is gripped at the centre of its length, where it is centred with great ease and rapidity. It is urged round from this centre point in its length, and separate tools turn each end, automatically if need be—the torsion on both being exactly alike, as also all other sources of error. He has also a vertical slotting machine of large size, with a double set of horizontal screw motions for the table, so that small motions or adjustments may be made by hand, or the cut stopped thus, without throwing out the automatic screw arrangements. A double shaping machine, of 12-inch stroke, with three tables, so as to enable the attendant workman to keep the tool constantly employed, and himself too, while the latter is working in adjusting the next piece to it, is a fine sample of a well thought-out and well executed tool. Whitworth's planing machine for his hexagonal projectiles is also shown at work, taking off the entire side of the hexagon at one sweep in breadth.

Hill & Sheppard, of Leeds, show many very excellent honestly-made and well-executed tools, though without pretensions to much novelty; as do also Sharp, Stewart, & Robinson, some of whose tools are of large size. Some of the heaviest and most meritorious tools in the Exhibition are shown by Cail & Co.; amongst these we may signalize a magnificent lathe, several vertical slotting machines, with peculiar motions, and a vast machine for slotting, planing, and boring armour-plate simultaneously.

Amongst the steam hammers we must not omit to notice Mr. Ramsbottom's remarkable 30-ton horizontal double-acting hammer, which needs no foundation. It is shown but in model, but five or six are working at Crewe Works. We should not either pass Mr. Haswell's, of Vienna, steam iron pressure moulder or hammer, by Egds, of Berlin. It is much to be regretted that this fine tool was not placed in an annexe, and its powers exhibited in moulding up huge lumps of iron like wax.

In the United States, amongst several remarkable tools, is a very large and a very peculiar planing machine, by Sellers, of Philadelphia, in which the bed is fixed, and is the foundation, in fact, of the whole of the moving parts of the machine. A heavy vertical spur-braced top frame travels in V-grooves at either side the bed, gripped between such grooves both upwards and downwards at its base, and carries the tool-holders from end to end, or for any required lengths. The tools are automatic in all directions. The power is conveyed to a pulley on the top of this travelling frame from the fixed laying shaft, and the arrangement by which the straps are maintained always of the same length and always taut, while yet the frame travels forth and back, is one of singular elegance. At our first view we were disposed to think ill of this machine, but it is one that improves upon acquaintance. There is an uncommonly nice American boring machine for small cylinders close by, from Bement & Dougherty, of Philadelphia, the boring bar passing end on through the hollow head that causes it to revolve. The design is beautifully carried out. The idea is not novel; the writer of this notice himself constructed a machine of the same sort nearly twenty years ago, and which he believes is still working in Dublin.

There are several toothed-gear cutting and shaping machines—one by Rens & Colson, of Gand, of much merit. Cail, Halot, & Co., of Bruxelles, show admirable tools; as also do Hartmann and Zimmermann, both of Chemnitz, in Saxony. A boring machine for cylinders in a vertical position, up to 2 or 3 feet diameter, the bar rotated by a worm wheel and endless screw, is a capitally designed tool.

Of smaller tools the multitude is endless, the merit various, but almost always great. Of tools for special purposes, but not quite coming within the class of machine tools, such as the fine pantographic apparatus of Wagner, jun., of Berlin, for multiplying, reducing, enlarging, or reversing engraved plates of copper or steel, for example, it would take a volume to give an adequate account.

Of tools for wood-working there is not such an abundance relatively, perhaps, as there was in 1862; but there is all the usual display of rabbating, edging, grooving, mortising, carving, buhl cutting, hand and vertical and circular saw cutting, turning and lathe copying machines, by all the greater countries. Some of the American wood-working machines are of great merit, though the plain iron frames, and in some instances even wooden frames, obscure their merits from the commonplace or superficial observer. One copying lathe, for turning delicate wood balusters, such as those used for the open work on top of the divisions between desks in bankers' offices, is an exquisitely designed tool, and its operation appears perfect. The piece of wood, rough and *square* from the saw, is instantly centred; one tool trips it to the round, the round part passes through a supporting travelling collar; a second *pair* of tools follows, which copy by an edge suitably formed to the contour of the baluster and fixed to the lathe bed, and reduce the wood nearly to form; when lastly a knife edge, the blade of which, ground and formed in a plane orthogonal to its face, also to the *finished* contour of the baluster, comes down diagonally over the turned piece, still revolving, and removing a delicate film of wood by its diagonal razor-like shave, leaves the baluster finished and smooth enough to take paint at once, or if of hard wood to be French varnished.

A little *automatic* machine for turning cotton bobbins and finishing them at one operation, exhibited by Williamson, in the British section, is of great merit.

These are but a very small and desultory selection, as they have occurred to us, from amongst the vast display of tools now in the Champ de Mars. Let not Englishmen delude themselves longer, whether for peace or for war, hereafter, with the long prevalent notion that our tools, like our coal and our workmen, are unrivalled; and that we can, without great future and immediate exertion, maintain our ascendancy in the one, or, in the event of the other, be able to repair losses at a rate and with an enduring continuity that continental nations cannot follow.—Ed.

PRUSSIAN PATENTS.

Owing to the recent changes in the kingdom of Prussia, a Prussian patent now covers the states of Hanover, Holstein, Frankfort, Nassau, and Hesse-Cassel. Hitherto a separate and independent patent had to be obtained in each of the above states.

SPHERICAL ROTATORY RAG-WASHING MACHINES.

(*Illustrated by Plate* 8.)

We are indebted to the *Publication Industrielle* of Mons. Armengaud Aîné for the plate engraving and following description of these washing machines. They are the invention of MM. Planche & Rieder, whose designs have been ably carried out by the constructors, Messrs. Seraphin Brothers, of Paris, and have been in successful operation for some time in several large paper mills in France. These machines are constructed to work either together or separately, being driven from one common driving mechanism, provided with clutches so disposed as to enable either one to be stopped independently of the other, according to the requirements of the manufacture. A special arrangement admits of their being worked by manual labour, in order to facilitate the charging and discharging of one or other of the spherical vessels.

Fig. 1 (Plate 8) is a vertical section taken through the axis of the two spherical washing vessels; fig. 2 is a plan of the underside of the driving mechanism; and fig. 3 is a side elevation of the same. On fig. 1 are grouped the various systems in use for the introduction of the steam or the washing liquor, whilst the various modifications of which these systems are susceptible are also indicated. Each of the vessels, A and A′, are constructed of $\frac{3}{8}$th boiler plate, and are of a diameter of about 6 feet. They are each capable of containing a charge of about 1300 lbs. of rags. The pressure of the steam employed is equal to about five atmospheres.

Each sphere is provided internally with a perforated plate, *a*, of less thickness than the shell, which constitutes a species of double bottom, and which is secured to the inner side by double angle iron, *b*. The steam is introduced into the annular space, *a′*, formed between the shell of the sphere and the inner plates. The perforations in the latter plate are about $\frac{5}{16}$ths of an inch in diameter, and 1 inch apart. It is provided either with pallets, B, as shown in the left hand sphere (fig. 1), or with strong teeth about 18 inches long, the object of which is to tear and agitate the rags.

The sphere and its double bottom are provided with an opening to receive a cylindrical cast-iron mouthpiece, C, intended for the introduc-

Fig. 3.

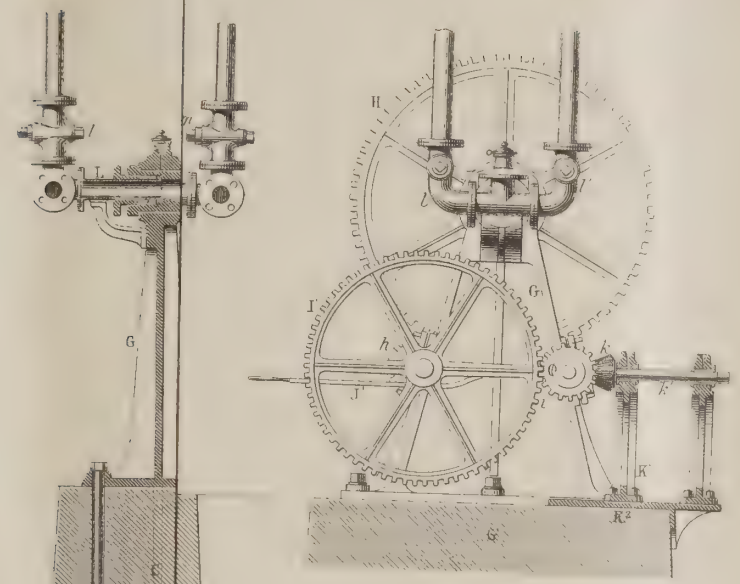
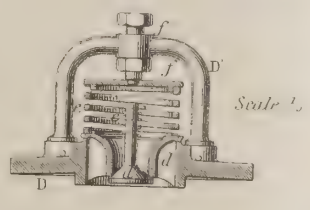


Fig 5.



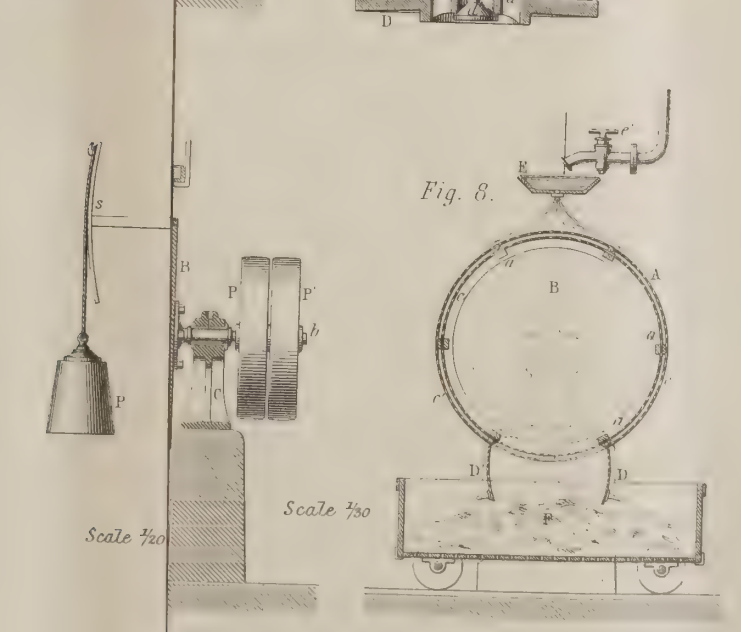


Fig. 8.

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ARMENGAUD AÎNÉ.

PARIS EXHIBITION 1867.

SPHERICAL ROTATORY RAG WASHING MACHINES.

CONSTRUCTED BY SERAPHIN BROTHERS,
PARIS.

Fig. 1.

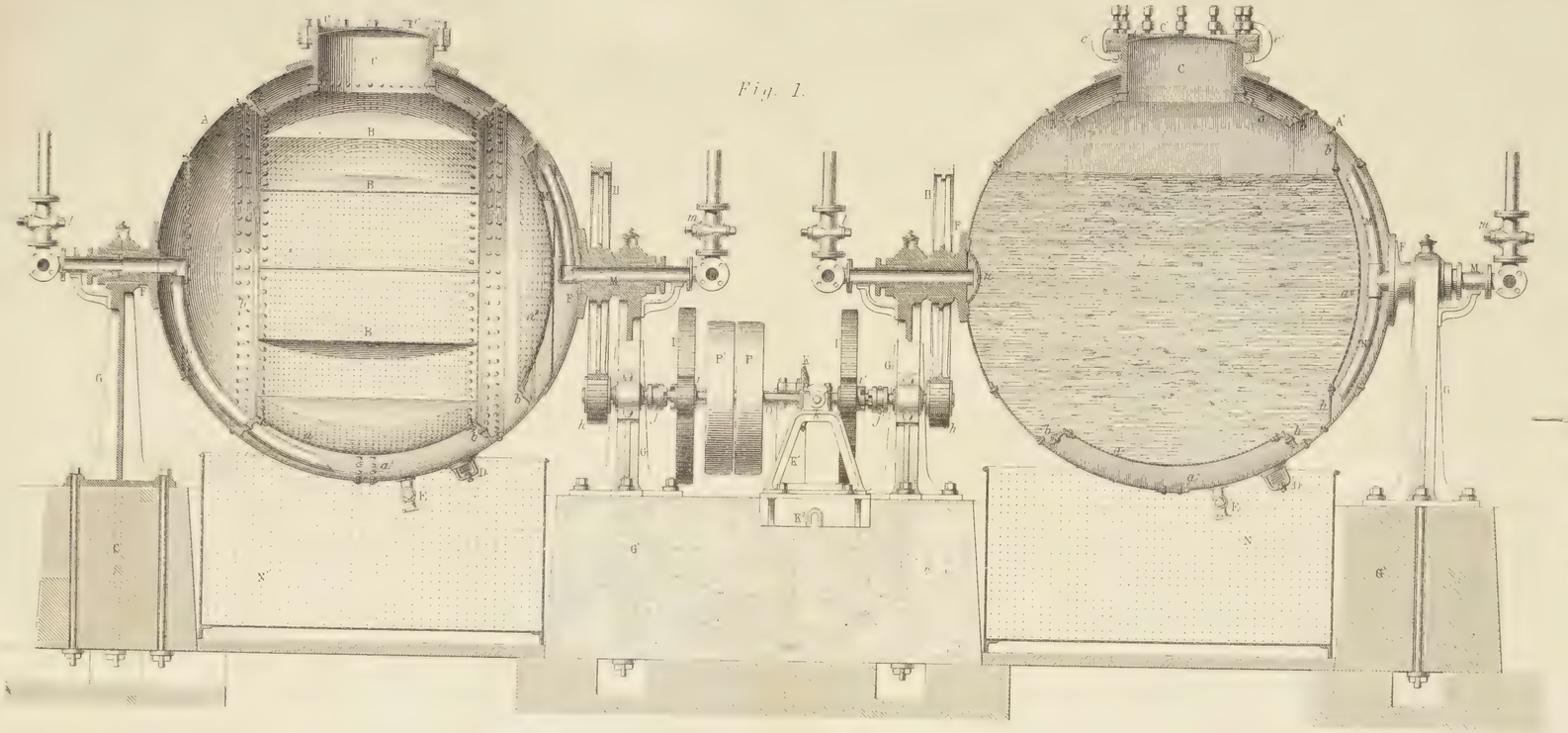


Fig. 3.

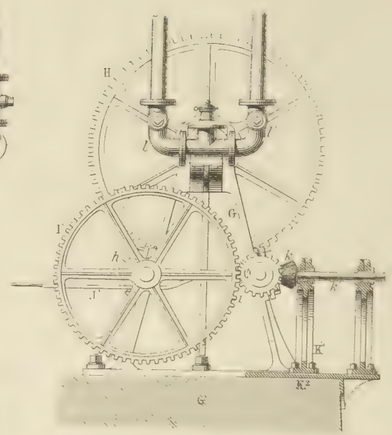


Fig. 5.

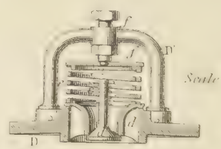


Fig. 4.

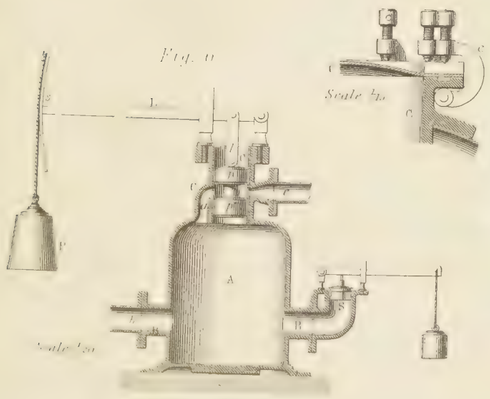


Fig. 2.

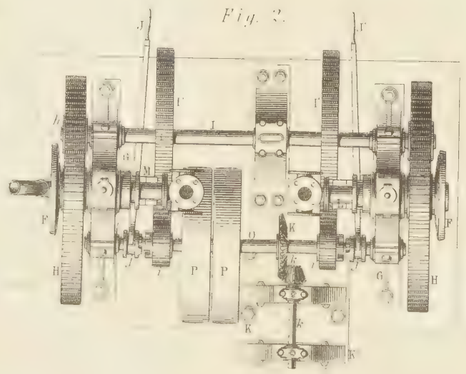


Fig. 7.

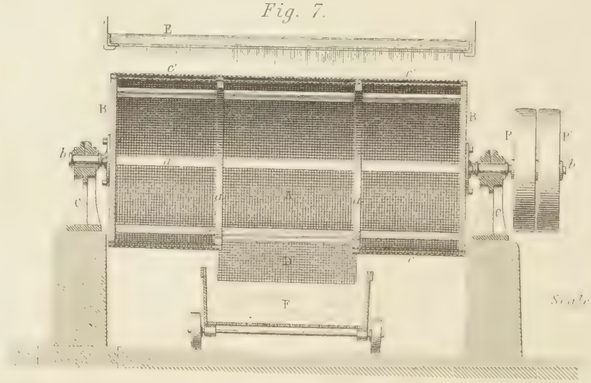
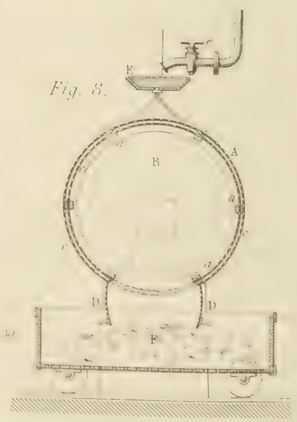


Fig. 8.



Scale ⅜s for Figs. 1. 2. 3.

...nt. Offices. 47 Lincolns Inn Fields London

ARMENGAUD AÎNÉ.

tion of the rags; and which, at the same time, serves as a manhole to admit of the adjustment of the internal apparatus, and to facilitate repairs. This mouthpiece is closed by the cover, C′, secured either by screw bolts, *c*, as shown on the left hand sphere, or by screw clamps, *c′*, shown on the right hand sphere, and also in the detailed view, drawn to an enlarged scale (fig. 4). Each of these clamps is pivoted in such a manner that it may turn on one side when the cover is removed.

A valve, D, is provided on the outside of each of the spheres, which operates not merely as a safety valve to regulate the pressure, but also as an air valve, if from any cause whatever a partial vacuum be produced. This valve, which is shown in vertical section at fig. 5, is composed of a brass seat riveted on to the sphere, on which rests a clack, *d*, hollowed out in the middle, to make room for the spindle of a smaller clack, *d′*, held firm by means of a small spiral spring, *e*, wound round the spindle, and supported on one side by a cross-piece, and on the other by a pin engaging in the spindle itself of the large clack. This is likewise held fast on its seat by a more powerful spring, *e′*, which takes its bearing under the plate, *f*, the circular rim of which it surrounds; the plate is held by the screw, *f′*, the position of which in the cross piece, D′, may be regulated by means of the jam nut; and the cross-piece is also screwed on its seat, D, by pins. The effect of this arrangement of valve is that, when the pressure is unduly increased, the clack, *d*, compresses the spring and allows the steam to escape; if, on the other hand, a vacuum occurs from any cause whatever, the small clack, *d′*, opens inwards and thus admits the air.

Each sphere is further provided with a cock, E, placed opposite to the manhole, for the purpose of running off the lye or other liquid contained therein.

Both the spheres are supported by two hollow trunnions of cast iron, F and F′, which turn in the pedestals of the supports, G, bolted to the masonry, G′. One of the trunnions, F′, which is longer than the other, carries the large wheel, H, in gear with the pinion, *h*, keyed on to the intermediate shaft, I, which is mounted in brass bearings in the two supports or frames. This shaft carries a wheel, I′, for each of the spheres, which wheels gear with the corresponding pinions, *i* and *i′*, keyed on to the main axis, O, driven direct through the large pulleys, P, P′. The shaft, I, which drives both the machines, is provided with two clutches, *j* and *j′*, actuated by the two levers, J and J′. The teeth of these clutches are arranged so as to engage in the corresponding clutch teeth of the pinions, *i* and *i′*, in such a manner that they will be in gear with the clutches when required. As a result of this arrangement, either of the pinions, *i* and *i′*, may be thrown into gear, so as to actuate one or other of the spheres, or both the spheres may be made to work simultaneously.

For the purpose of rotating the two machines by hand in order to bring the manhole either to the top side for charging or to the under side for emptying, there is provided on the main shaft a bevel wheel, K, gearing with the pinion, *k*, which is keyed on to a vertical shaft, *k′*, turning in cast-iron pedestals, K′, fixed on the foundation plate, K^2. The end of the shaft, *k′*, is made square, and a crank or fly-wheel may be fixed thereon. The diameters and positions of this gearing are so arranged as to transmit to the spheres a very slow motion of about two turns in five minutes, as ordinarily practised for this description of apparatus.

As before stated, each of the trunnions, F and F′, is hollow, but the steam and washing materials may be introduced by various contrivances. One of these is shown applied to the left hand sphere (fig. 1). It consists of a central pipe, L, which is secured by a small support bolted to the main bracket, and communicates with a forked pipe, to which are connected two cocks, *l* and *l′* (figs. 1 and 3), for the purpose of clearing the conducting tubes. To the interior of the sphere is fixed the pipe, L′, bent to the shape of the circumference of the sphere, and passing into the space comprised between the outer shell and the inner perforated plate, and of course revolves with the spherical vessel.

Through the opposite trunnion, F′, passes the fixed pipe, M, which communicates at one end with a forked pipe provided with two cocks, *m* and *m′*; whilst the other end passes into the sphere, and is connected by a screwed elbow-joint to the pipe, M, curved in a vertical direction. An internal casing, a^2, concentric with the sphere, and which, like the plate, *a*, has a number of perforations made therein, is employed to protect this pipe from the pressure of the rags. This pipe receives the steam, and by its means a constant current is kept up, the energy of which may be easily regulated as required.

The right hand sphere is provided with another arrangement, wherein the steam is directed into the vessel through a rose jet, *n*, fixed to the inner side of the same; at the opposite side are two fixed tubes, M and N, one of which is curved upwards to receive the vapours, and the other bent downwards to carry away the lye or other liquor. These two pipes are connected by a screwed T-joint with the conducting pipe, M, passing through the hollow trunnion, which in this case is divided into two thoroughfares by means of a longitudinal partition; the conducting pipe is attached to the frame as in the other arrangement. The interior tubes, M′ and N, are protected by a perforated casing, almost concentric with the circumference of the sphere, and differing in construction from that applied to the left hand sphere only by being secured by single angle iron, *b′*, instead of double angle iron, *b*.

A perforated metal vessel or receptacle, N′, may be placed between the supporting walls of masonry in order to receive the rags that have been washed, and to allow the liquor to drain therefrom; and it may be provided with wheels or rollers to facilitate its transport from place to place.

These machines operate in the same way as those of a cylindrical form. They are placed in the position shown in fig. 1 for receiving a charge of rags through the manhole, after which the cover, C′, is secured in its place, so as to perfectly close the aperture. In order to discharge the contents of the vessels, when the operation of washing is completed, the lye is drained off through the cock, E; the sphere is then turned round, so as bring the manhole into the opposite position of that shown in fig. 1, when such of the rags as are sufficiently drained will drop through on to the ground, or into the receptacle, N′, shown in fig. 1, whilst the remainder of the rags which adhere to the pallets are released by turning the sphere several times, when they may also be dropped out.

In order to maintain a constant and uniform pressure of steam, a governing apparatus is employed, which, when once regulated, admits of the introduction of the steam only at the pressure desired. This apparatus, which is shown in vertical section at fig. 6, and which is a very useful appendage, was invented and manufactured by Messrs. Seraphin Brothers, who have designed it with a view to render its action as regular as possible. It consists of a steam chamber, A, having a cylinder, C, cast on the top, and two pipes, B and B′, at opposite sides. The cylinder, C, is lined with a copper socket, which is accurately bored to receive a double piston, *p*, *p′*, provided with metallic packing, between the two parts of which double piston communication is established between the steam pipe, *c*, and the steam chamber, A, by means of the passage, *a*. At the top of the piston, *p*, there is a projection, to which are attached the links, *l*, of the lever, L, the end of which is provided with a sector, *s*, which acts as a guide for the cord or chain of the counterweight, P. A safety-valve, S, of ordinary construction is fixed on to the pipe, B, and is regulated to the required pressure of the steam; and the pipe, *b*, the flange of which abuts against a flange on the pipe, B′, conducts the steam to the spherical vessels. The safety-valve, *s*, being regulated so that the pressure of the steam shall not exceed, say, four atmospheres, the counterweight of the lever, L, should be in such a position that the space between the two pistons, *p* and *p′*, may leave a free communication between the steam pipe, *c*, through the passage, *a*, to the steam chamber, A; but if the steam introduced through the steam pipe, *c*, be of a pressure of say six atmospheres, it raises the pistons, which then reduce the size of the passage, so as to retain the steam in the chamber, A. Should by chance the pressure in the chamber, A, be increased beyond due limits, the safety-valve would immediately come into operation, and by diminishing the pressure, prevent any danger arising therefrom.

The Rotatory Washing Machine, shown in longitudinal and transverse section at figs. 7 and 8 respectively, was constructed by M. G. Jouhaud, manager of the Val-d'Enraud Paper Works. It is composed of a cylindrical cage, A, formed of annular and longitudinal ribs of wood, *a*, jointed to two wooden ends, B. This cylinder is supported by the trunnions, *b*, mounted in the two pedestal bearings, C, one of which latter also carries the large fast and loose driving pulleys, P and P′, for the transmission of motion to the machine.

This cage is covered with two layers of brass wire-gauze, *c* and *c′*, one of which (No. 60 gauge) is sufficiently fine to prevent any loss of pulp, whilst allowing free entry and exit to the water; and the other (No. 10 gauge) is made strong enough to support and shield the former.

There is a door, D, in the middle for the introduction of the pulp,

and also to afford means for the discharging of the same, for which purpose the apparatus is turned to the position shown in the drawing.

A strainer, E, is suspended above the apparatus, into which filtered water is conducted by a tube fitted with a cock, *e*, placed within reach of the workman, so that he can regulate its supply at pleasure. It escapes through a longitudinal slot made in the strainer, and passes through the wire gauze and the pulpy material, and escapes at the bottom.

The water escapes from the strainer directly the cock is turned, and falls direct on to the apparatus, to which rotatory motion is imparted. This water penetrates uniformly between the two metallic coverings, passes through the pulp, washes and agitates it, and carries with it through the machine in its rapid course all the residue of chlorine, acids, and lime. The pulp being retained free from contact with the impure water which escapes, is washed by the clear water continually supplied.

Practice soon shows the length of time required for washing the pulp; but before this experience is acquired the workman may determine when the pulp is sufficiently washed by the application to the washed pulp of a solution in tepid water of starch or fecula and ioduret of potassium. The pulp will be tinted of a dark blue colour, and the sample should then be preserved for future reference.

After washing for half an hour (the machine turning very slowly, say not more than one or two turns per minute, so as not to injure the layers of wire gauze), if the machine be stopped, and a portion of the pulp be again submitted to the test of the liquid, it will be found to be tinted a light blue, instead of a dark blue. It should then be washed a quarter of an hour longer; and on again testing it with the liquid, the discoloration produced will be of a lilac colour, which is an indication that the washing process has been continued long enough.

It will be found convenient to place the axis of the machine about 3 feet from the ground, as shown in the engraving, in order that the door, D, may be within easy reach of the workman, and that there may be sufficient space underneath for the truck, F, intended to receive the pulp.

When the operation of washing is completed, the cock, *e*, is closed and the door opened, and the apparatus is emptied in a few minutes into the truck placed underneath, after which the truck is withdrawn, and the contents of another truck, which has been loaded with pulp during the time the washing was in progress, is turned into the rotatory washing machine, and the operation of washing is recommenced. While this is going on, the workmen refill the supply trucks, and attend to the other requirements of the workshop.

Three of these washing machines, of a length of about 6 feet and a diameter of 3 feet, will be sufficient to wash the white pulp of an establishment producing upwards of 2000 lbs. of paper per diem.

MECHANIC'S LIBRARY.

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RECENT PATENTS.

GRATE BARS.

J. H. JOHNSON, *Lincoln's Inn Fields. Communicated from* SAMUEL HARRISON, *Philadelphia, U.S. Patent dated 4th October*, 1866.

THIS invention relates to an improvement in that class of grate bars which consists of a number or group of ribs cast together with spaces between the ribs; and the improved grate bar consists of a deep and shallow rib or ribs, combined in one casting, substantially as described hereafter, so that the bar may be more easily moulded and cast; may afford a better circulation of air between the ribs; may be less liable to be choked with cinders and slag; and be lighter, and consequently more economical, than ordinary grate bars having a number of ribs of uniform depth.

Fig. 1 of the engravings is a side view of the improved grate bar; fig. 2, a plan; fig. 3, a transverse section on the line 1—2, fig. 1; figs. 4 and 5 illustrate modifications of the improved grate bar.

On reference to figs. 1, 2, 3, A is the bar, which in the present instance is composed of the three ribs, *a*, *a′*, and *a″*, connected together at the opposite ends by webs, *b b*. and at suitable intermediate points by webs, *d*, *d′*, and *e*, the whole being cast in one piece. The outside ribs, *a* and *a″*, are much shallower than the middle rib, and as seen in fig. 1, are made in the form of an arch on the underside; they may, however, be straight. The middle rib is made in the form of an inverted arch. The ribs, *a*, *a′*, and *a″*, are arranged at a proper distance apart, to suit

Fig. 1.

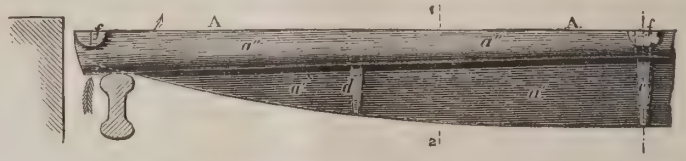
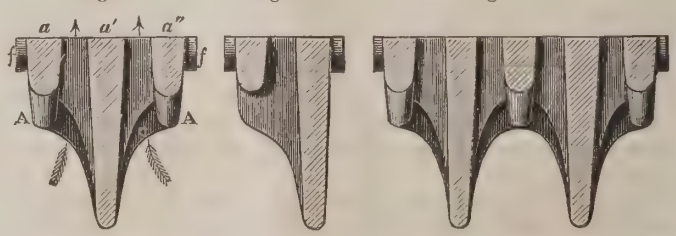


Fig. 2.

the fuel which has to be used in the furnace, of which a number of these bars form the grate, and on the exterior of the outer ribs, *a* and *a″*, are the usual projections, *f*, by means of which the bars are maintained at a proper distance apart from each other.

The advantages of the improved grate bar may be enumerated and described as follows:—First, they can be moulded and cast with greater facility than ordinary bars, in which a number of ribs of uniform depth are cast together. Second, there will be a more free circulation of air through the spaces between the ribs of the improved bar, than through bars having ribs of uniform depth, as the air has to pass through much shallower openings in the former than in the latter case (see arrows, fig. 3). Third, there is less liability of the spaces between the ribs becoming choked with slag and cinders, as will be readily understood

Fig. 3. Fig. 4. Fig. 5.



without explanation. Fourth, the intermediate rib, *a′*, of the form shown, imparts the desired vertical rigidity to the bar; hence the outer ribs may be of the reduced depth illustrated and described, thereby effecting a corresponding reduction in the weight of the bar, and a saving of material. Although it is preferred in ordinary cases, a bar composed of three ribs as described above, bars with five ribs, as seen in fig. 5, or with six ribs, or even with two ribs, as illustrated in fig. 4, may be made and used with good results.

It will be seen, on reference to fig 1, that the outer ribs at each end of the bar project below the middle rib, the outer ribs only resting on the bearer. This arrangement possesses two advantages: first, a more steady bearing is afforded to the bars than if the whole of the ribs rested on the bearers; second, openings are presented for the free passage of air in the direction pointed out by the arrows, fig. 1. The upper edges of the ribs may either be rounded, or have grooves formed in them.

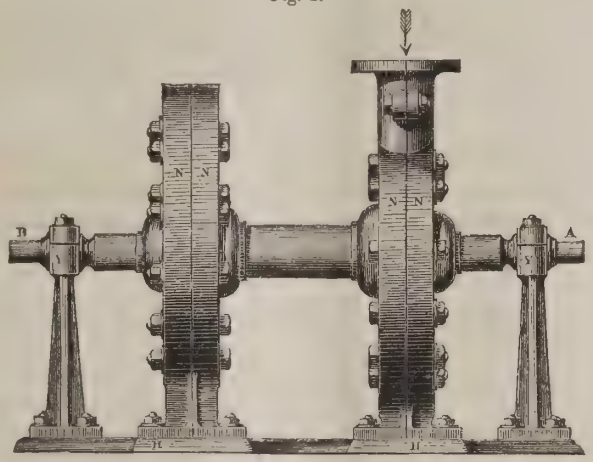
MOTIVE-POWER ENGINES.

SHOLTO DOUGLAS, *Blairgowrie.—Patent dated 23rd May*, 1866.

THIS invention, which has for its essential object a certain peculiar arrangement of machinery or apparatus to be actuated by water, steam, compressed air, or other liquids or gases, consists as follows:—A wheel or wheels is or are carried on an axle or axles, which rotate in water, air, or steam tight bearings fixed in the sides of a cylinder or case. The case is so constructed that the wheel revolves freely within it, and in such manner that as little wear as possible may result from

the movement of the wheel therein. On the circumference or in the body of the wheel several curved passages are made: these passages are so formed that the water, steam, compressed air, or gas entering them leaves the passages by escaping therefrom to the same direction, or approaching to the same point on the wheel that it entered—that is to say, the passages are bent into a curved figure, and by the resistance opposed to the passage of the water, steam, compressed air, or gas, as it issues from the return end of the passages, additional power is obtained over and above what would be due to the pressure of the column of

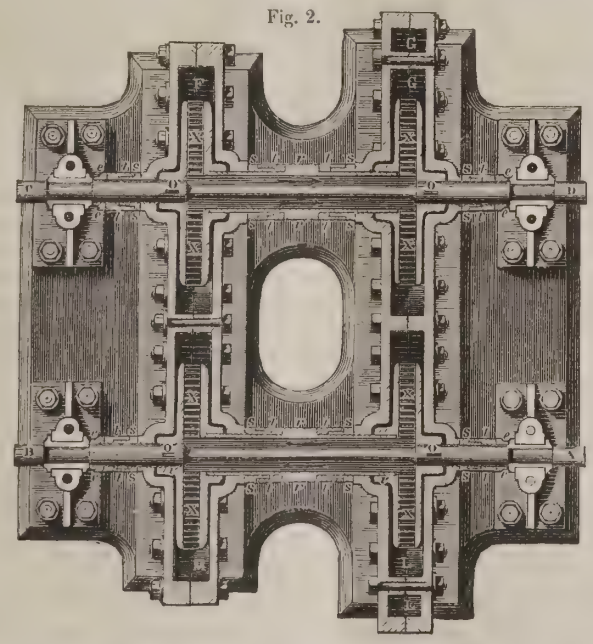
Fig. 1.



water, steam, compressed air, or other fluid, under ordinary circumstances. It is to be understood that the number of such passages employed will be varied to suit any particular circumstances.

Fig. 1 of the engravings is a side elevation of one form of the improved motive-power engine; fig. 2 is a horizontal section across the axis of fig. 1; fig. 3 is a transverse section, and fig. 4 is another transverse section, showing the interior arrangements. In all the figures the casing of the engine, marked N, is by preference made of cast iron, and bolted to the sole plate, as shown; the halves of both the casings

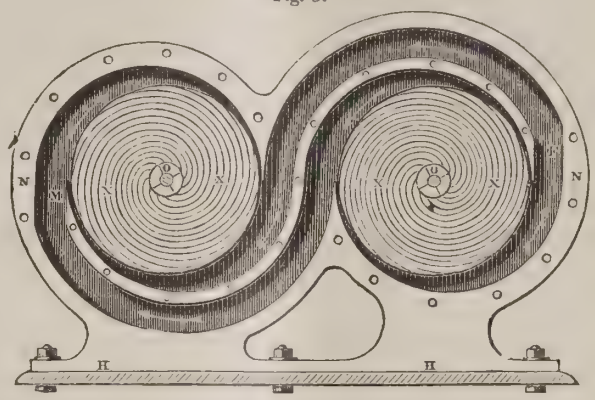
Fig. 2.



themselves being held together by through bolts, and when thus united forming the cavities between them, in which the wheels of the engine revolve. The wheels, X, in this modification (which is a compound engine having four wheels) are keyed on to the two cross shafts, D and E, which pass through the central parts of the casings, and are held in position so as to revolve in the bearings, as shown. From the central part of one wheel to the central part of the other wheel on the same shaft, a tubular or annular passage extends, through which the water passes through the system until it is finally discharged at the last wheel, X, of the system. The arrangement of the shafts will be fully understood from figs. 1 and 2, as well as the mode of fixing the tubular passage, O, between each pair of wheels. The tubes are secured to four thin projecting pieces, running longitudinally between the wheels, X, as more particularly seen in transverse section at figs. 3 and 4. The tubes, H, have also their ends fixed into the bosses of the wheels, shown at fig. 2.

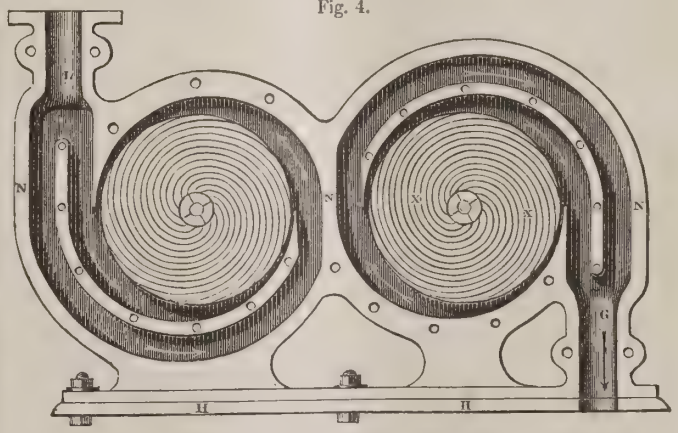
As it is necessary to maintain a joint without leak at those points where the shafts and tubular passages pass through the casings, this is effected by the introduction of the collar or face rings, S, which are arranged to slide freely on the shafts, as well as on the tubular passages; and they are carried round with the shafts and passages by means of

Fig. 3.



small projecting pieces. Behind the rings, S, packing rings, *t*, are introduced, and these preferably consist of thin bands of vulcanized india-rubber, or they may be made of any other suitable elastic material. These are attached to the outside of the shafts and passages; those on the shafts have a firm abutment against the fixed collars, *e*, while those on the passages abut against the central projecting piece, *r*, the elasticity of the packing when compressed causing the face rings, S, to be pressed continually against the faced bosses of the casings. The pedestals, Y, which carry the bearings for the shafts, D and E, are held to the sole plate, B, by bolts. The wheels themselves are made either of cast iron, brass, or other suitable metal or material.

Fig. 4.



When employed for actuating machinery, either a belt pulley or pulleys, pinions or spur wheels, a crank or cranks, may be fixed on any of the shafts for transmitting motion and force as may be required. It is to be understood that, besides being used as a stationary engine, it may also, by suitable arrangements, be made to fulfil the several functions of a locomotive or marine engine by the introduction of suitable connections to the travelling wheels of the former, and the propulsive apparatus of the latter. As such an arrangement is at once evident to the practical engineer or mechanic, it is not necessary here further to describe it.

This improved motive-power engine is operated as follows:—The motive agent employed, whether it be steam, compressed air, or gas, or water, or other liquid or fluid, is admitted into the casing by the passage, L, whence it passes into the curved passages of the first wheel,

x, being separated so as to fill all the passages, and completely surround the wheel by means of the divisions, *p p*, figs. 3 and 4, causing, by its action on these passages a revolution of the wheel, C^1. Passing from the central end of the curved passages, it proceeds by the tubular passage to the central part of the other wheel; whence by centrifugal action it is impelled to the outside ends of the passages, leaving which, it passes from the second wheel, x, figs. 3 and 2, over and under the diaphragm, *t*, to the third wheel, C^2, on which it acts similarly to the first wheel; the motive agent, whether it be a fluid or liquid, is directed along the second central passage to the fourth wheel, on escaping from which it is carried off by the duct, G.

Although a fourfold system of engine is here shown, it is to be understood that under this invention is included the use and employment of single-wheel engines, as well as engines in which the number of wheels is increased to whatever number may be necessary.

It may be explained, however, that in increasing the number of wheels, the speed is diminished, and the power increased, in a corresponding ratio; so that in cases where high speed is required, it will be found advantageous to use a single engine; whilst in other cases, where greater power and a less speed suffice, it is better to multiply the number of wheels. With engines constructed according to this invention, an efficiency of 84 per cent. is said to be obtained.

LAW REPORTS.

UNITED STATES LAW CASE.

What Constitutes a Trade-mark—Important Decision to Manufacturers.—The Wilcox & Gibbs Sewing-Machine Co. *against* Joseph W. Bartlett.—Court of Common Pleas, Special Term, May 30. Before Judge Daly.—In 1857, James E. A. Gibbs, of Virginia, invented the mechanism of a new sewing-machine, the prominent characteristic of which was that it required the use of but a single needle and thread. That he might associate his name permanently with this invention, he constructed the machine in the form of the capital letter G of the Roman alphabet; with his associates introduced it into the market; and by advertising it as the letter "G" machine, and the constant use of that letter in the business, and in connection with the machine, claimed to have adopted and appropriated the letter itself, as well as the special shape of the machine, for the trade-mark and symbol of the business. In consequence of the prejudice then existing against single-thread machines (those called double-thread being principally used), the sales of the machine in question were, for a considerable period, comparatively few in number; but finally the machine proved a success, its business was fully established, and it became popularly known as the "letter G," as well as the "Willcox and Gibbs," machine. The complainant's company was organized to meet the demands of the increasing business, and succeeded to all the rights of the original owners, including the trade-mark in question. It was further proved that after the success became an established fact, the defendant introduced upon the market a machine in imitation of the "Willcox and Gibbs," which so closely resembled the "letter G" form, that upon an ordinary inspection of a purchaser it would be readily taken for it; that the defendant established agencies and advertised his machine, and pushed its sale in this form for the purpose of availing himself of the reputation and credit of their machine to sell his own, which was greatly inferior to theirs in mechanical construction, cost, and practical value; that purchasers were deceived by this resemblance, in fact, and that it was principally through this similarity that the defendant was able to sell his machines at all; that when put to practical use it failed to do its work, and that on account of its resemblance, and the course of business of defendant and his agents, its faults and defects were imputed to the genuine "letter G" machine, greatly to the injury of its reputation, and the plaintiffs' trade. Other facts were incidentally stated, but the above is the substance of those on which the plaintiffs relied.

Upon these facts and the return of an order to show cause why an injunction should not issue, L. E. Chittenden, Esq., counsel for the complainants, insisted that the complainants had not only established the form of their machine, as their trade-mark, but had also established the exclusive right to the use of the capital Roman letter G as their trade-mark and the symbol and device of their business; that Gibbs was the first person who had ever made a sewing-machine in the form of this letter, and that himself and his successors had appropriated the letter G itself, as well as the special form of the machine, as such trade-mark and symbol; that they had used it openly and uninterruptedly for more than eight years; that as the initial letter of Gibbs's name it indicated ownership; that all the facts existed necessary to constitute it a trade-mark, and that the defendant had no more right under the circumstances to use it than the whole name of Gibbs; that his use of it either in the form of a sewing-machine, or in the way of a representation, his construction of a machine in this form, or the use of the letter G in connection with the business as a trade-mark, operated to mislead the public, and seriously injure the plaintiff. He also claimed that as there was no special utility in any particular form, the resemblance which defendant's machine bore to the complainant's without other proof, furnished presumptive evidence of defendant's intention to avail himself of the reputation of the Willcox & Gibbs machine, and to induce purchasers to believe they were identical: no other reason could be assigned for the similarity, and that this fact alone, unexplained, was an invasion of the rights of his clients in their trade-mark, which equity would restrain. While, therefore, he did not seek to restrain the defendant from the sale of any other form, he insisted that he ought to be enjoined—

First: From making or selling any machine *in the form* of the plaintiff's.

Second: From representing that any machine so made by him was the manufacture of the plaintiff, or from using any devices or tokens to induce such a belief.

Third: From using the letter G as a trademark, device, or token, in connection with any sewing-machine or sewing-machine business.

The following order was made by Judge Daly in the case:—

Upon motion of L. E. Chittenden, Esq., of counsel for the complainants, this Court doth hereby strictly prohibit and enjoin the said defendant, Joseph W. Bartlett, and each and every of his servants and agents, and all persons acting under his authority or control, or by his consent or permission, from counterfeiting or imitating the trade-mark, device, or symbol of the complainants, described and figured in the said complaint, so devised and first used by said Gibbs, and applied to the Willcox & Gibbs sewing-machine, and now owned by the complainants, and from using or permitting any other person to use the same, either as a form for a sewing-machine, or as a trade-mark, device, or symbol of or in connection with the business of making or selling sewing-machines, and from selling or offering for sale, advertising, or in any manner holding out to the public any other form, style, or figure of sewing-machine as the letter G machine; and from claiming, pretending, or holding out to the public any other form, style, or figure of sewing-machine as the complainant's manufacture; and from using the said form of the capital Roman letter G, or any imitation thereof, as a trade-mark, device, or symbol for a sewing-machine, or the business of making or selling sewing-machines, so long as this order shall remain in force, and not be modified or set aside by competent authority.

REVIEWS OF NEW BOOKS.

Readwin's Index to Mineralogy. 8vo, 45 pp. Spon, London. 1867.

This Index, as is declared upon the cover, is little more than an alphabetical list of the minerals (about 2500 in number of species) contained in the collection of the British Museum, giving also the names (by symbol) of their constituent elements, and the place where the specimen is to be found in the Museum. There can be but one opinion as to the usefulness of some such brief and concise list as this to all interested in scientific mineralogy. We can scarcely say, however, that this Index, as now made, quite meets our own views as to what such a production ought to be. We shall say nothing as to the existence of a whole page of errata out of forty-two pages of text; nor of three pages of supplement to so small a foregoing, though the former might as well have been corrected in the press, and the latter inwoven in the alphabet itself. We do, however, object to the statement that the Index gives *the composition* of any mineral in the entire list, except it be of an odd one, which consists wholly of a single elementary substance. To write after emerald, Al × Be Sil, is not to give the *composition* of that gem, it is simply to say, it contains more or less of alumina, glucina, and silex; and if we turn back to beryl we shall just find repeated Al × Be Sil, so that, for aught the Index says to the contrary, beryl and emerald may be but names for the same thing; while we are left wholly in the dark as to what determines the colour of either gem. To make such an Index as this really valuable, and a good hand-guide for the Museum, there should be *two* Indices, the one alphabetical, the other arranged upon the chemical basis into groups and families. To each should be given with each mineral a concise *formula* of composition—not only what elements (and the *whole* of them) the mineral *typically* contains, but their proportions. With this, and a reference to place in the collection, it would be of value; at present it seems to us of but little. It is to be hoped that the "more extended work on the same subject," stated in the preface to be "in preparation" by the author, may not perpetuate the laxities of this, which is declared to be "little more than the index" to it. An extended work that should ignore the relations as to weight that the constituent elements of minerals bear to each other, would form but a sorry addition to mineralogical literature.—Ed.

Essai sur la Défense des Eaux et sur la Construction des Barrages. Par F. J. P. Piron, Capitaine en Premier du Génie. 1 vol., 8vo, illustrated. Paris et Bruxelles. 1866.

This work, by a Belgian engineer officer, quartered at Antwerp, where we may readily imagine the subject was forced upon his attention by the questions as to the defence of the Scheldt, is a very clear and clever one. His final object is to point out a method, or rather a principle to be evolved into a method, the detail of which may be much varied, by which an enemy's armour-clad ships or floating batteries may be prevented ascending rivers, estuaries, &c., or entering harbours, to the best advantage on the part of the defenders. The subject is treated

all through in a calm, prudent, and genuinely scientific manner, and the author shows himself well able to test his own results, as he does, in fact, by rigid calculation.

The methods known for the defence of narrow waters, such as the above, Captain Piron says, are coast batteries, artillery placed in monitors, torpedoes, and by "barrages;" *i.e.*, blocking up the entrances, such as was practised in one of its varieties, and that the very crudest and most costly, by the Russians when they sunk their fleet at the mouth of Sebastopol harbour, and by the Northern Americans when they cruelly, and as it proved uselessly, sunk ships loaded with stone in the channels of approach to Charleston. The author discusses with brevity and clearness the disadvantages and possible shortcomings of each of these methods in succession, and brings us to the conclusion that upon the whole the method of "barrage" is the most effective of all defences, provided it be properly practised; but he then enters upon the consideration of the special methods by which it has been proposed being practised, and of the effects of each. He admits that sinking vesssels, as the Russians did, may form an effective defence; but he deems this the most costly of all proceedings, and well points out that the Russians only preserved their empty harbour and stronghold by the voluntary loss of their fleet; but he also points out in a very clear and detailed and exact manner that such a defence is of little or no use, except for a very short time, unless the ships or other obstacles sunk be immersed in still water, or upon a hard and immovable bottom. He proves, and illustrates by diagrams, what changes in the depth and form of any river, estuary, or tideway channel must be produced by the sinking of ship's hulls in any of these; for the regimen of a stream is, in fact, altered by any solid immersed in its section, however small, and where, as in this case, the relative bulk of the obstacle must be great, the alterations are rapid, and if the bottom be mud, or sand, or soft material of any sort, the removal and deepening or lateral alteration will be such as rapidly to render the barrage as a defence valueless. This is, in fact, what actually occurred at Charleston. All this leads up to the statement of his own plan, which consists, if very briefly stated, in closing the mouth of the navigable channel by two or more great floating bodies, one end of each of which is fixed (*i.e.*, secured) to a common fixed point, while each body is free to turn horizontally or float round radially this point as a centre, so as either to open the line upon the surface, or to close it, when in the latter position the extremities of the radii of these floating bodies rest against fixed obstacles. The bodies themselves he proposes to be enormous hollow masses of boiler plate, the external form being something like that of a fish laid on its side and sunk for about half its body to its median plane, then on the surface of the water. Each body would have an horizontal, and in its two orthogonal vertical planes, elliptic sections, and they would be double-skinned and cellular all over, and double celled—*i.e.*, triple skinned on the more vulnerable places, either to artillery or to ramming. They would rise but very little above the water surface, afford no effective foot-hold to land on, and as the author fairly enough shows, would be almost if not altogether invulnerable to attack, by either of the above methods at least. We cannot in a mere review go into constructive details; we may state, however, that M. Piron points out methods for the mooring and management of those huge hollow cellular leviathan floating *booms*, for that is what they really are, to which the practical engineer cannot take any very valid or strong objection. The scale upon which he proposes to act may be imagined when we say he states that his method is perfectly adequate to closing both ends of the channel between the Isle of Wight and the mainland of England, employing the forts and the shores as the *points d'appui* for mooring the booms. The volume is illustrated with clear lithographs, showing sufficiently the detail of construction which he proposes for the booms themselves, to prove to every practical civil or military engineer that they would be extremely difficult of injury upon the part of an enemy, however well provided. He asserts nothing of a mechanical nature for which he does not present proof in figures, and he proves, we think, satisfactorily, that booms of the sort and size, &c., he projects, could not be destroyed by artillery, by the very heaviest and swiftest ram ships, by torpedoes, nor by shells; and that nearly exhausts our means of effectual offence. In fact, if enough powder laid on top of one of these booms right across its narrow way, could be exploded to break it right in two, it might remain almost as much a bar to entrance as before.

Bottom fouling in sea water would not, until it had reached something enormous, be very disadvantageous; and, as to corrosion, they would last a quarter of a century, if not much more, and that is more than enough. Nor would the cost, even upon the gigantic scale of the Isle of Wight channel, appear to be so enormous as to be prohibitory when weighed against national disaster or loss of independence.

There is but one point as to the feasibility of what Captain Piron has brought forward, on which we entertain some doubts. We think he has scarcely given full weight to the prodigious stress that wind and tide together might visit upon any one such vast floating boom as this even holding quite in view its shallow draught of water—a mere covered skimming dish, in fact, acted on edgeways by the water. It would be a serious drawback to the utility of such defences if, in times of very bad weather, they sealed the mouth of the port or roadstead they were placed as much to defend against the shipping of friends as of foes by the impossibility of removing them. However, we do not deem this doubt, whatever may be its validity, as at all pressing cogently against the system, for we can readily see that means can be devised, not only to overcome by main force any resistance wave, wind, or tide might oppose to the radial motion of one of these vast booms, but that the great mass of such defence need never be moved in time of war, and that some one small portion alone should be made movable for navigation purposes, and be yet thoroughly safe as a boom, and fully commanded by artillery, as well as the whole channel there torpedoed.—Ed.

CORRESPONDENCE.

☞ We do not hold ourselves responsible for the views or statements of Correspondents.

CORLISS' ENGINES.

(*To the Editor of the Practical Mechanic's Journal.*)

Sir,—In reference to the patent double clip-valve gear as applied to Corliss' engines, which is alluded to in your journal for this month, permit me to say that I have adopted it for the last two years and upwards, and during that time it has given no trouble, the catches remaining sharp and unworn. Being satisfied of its suitableness, I now make all my Corliss' engines on this plan.

You state that while the Corliss' engine has undoubtedly great advantages, it has this drawback—that it is not possible to work it *fast*. This expression is somewhat indefinite. Of the various fixed engines of this kind which I have built, none run slower than 400 feet per minute speed of piston; one I can show of 24 inch cylinder and 4 feet stroke, running 440 feet, and this engine has driven a large factory day and night for upwards of three years, with so much satisfaction to the owner that he would decline to take a common engine were it offered him in a present. One I am now erecting is to run 480 feet per minute, and seven others in progress are all for speeds such as are indicated above.

In justice to the Corliss' engine, I trust to your inserting this letter in your next issue.

Yours faithfully,

ROBERT DOUGLAS.

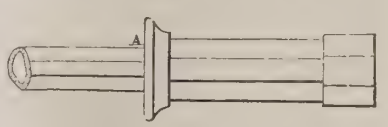
Kirkcaldy, Dunnikier Foundry, 11*th June*, 1867.

MALLEABLE CASTINGS AND FRACTURED COLUMNS.

(*To the Editor of the Practical Mechanic's Journal.*)

Sir,—We have read for a considerable time with great pleasure your able articles about "Some Points of Practice in Iron Founding," but as yet have not seen anything treating on malleable iron castings. Many of your readers, as well as ourselves, would feel very much obliged if you could explain the best, simplest, and most efficient manner how to produce these castings—viz., the treatment they have to undergo after having been cast in the usual manner. We believe that fine or small malleable iron castings are extensively used in England for sewing machines; and we have no doubt that if no good mode of treatment should immediately occur to you, some of your correspondents will oblige us with an explanation.

A second question is: Which are the best brands of Scotch and English pig iron adapted for long and thin hollow castings, as slight columns, &c.? Were it not for the sudden increase of diameter in different places of such columns, and the diameter would be alike from top to bottom, we should be at ease; but we have had so many columns torn asunder, or rather torn off, just where such diameter increases, thus at A, that we are at a loss to know the cause. You might, of course, suggest that at A the core ought to be thicker accordingly, but this cannot be done in all cases; for instance, at the head of a column where the headpiece, with leaves and flowers, &c., are cast on to the column, and the bottom moulding, which is there raised into the top box, does not allow of a thicker core being put in, and where above this headpiece the column is to get a small diameter again; in fact, the castings tear while contracting.



We have been in the habit of taking No. 1 Coltness ($\frac{1}{2}$) and G. W. L. No. 3, or Claylane No. 3 ($\frac{1}{2}$), for the last fifteen years and never had these occurrences, Is it that Coltness pig iron is getting worse? Lochgelly, Langloan, Almond, Forth.

all No. 1, have been tried by us in vain, and it is to us a complete riddle, the more so since our fan blast as well as our cokes (North Bitchburn or Slunwick) are the same as formerly. If, therefore, your valuable time should permit you to say a word or two in your articles about the proper proportion of mixture (⅓ Coltness or Gartsherrie, and ⅔ a harder brand perhaps, which we also tried), we should indeed be under great obligations to you.

We are, Sir, your most obedient servants,

EDUARD BEGER & CO., Founders.

Altona, *6th June*, 1867.

[The subject of making castings for what is called malleable cast iron will receive due and full attention at the proper time in our series of articles on the Practice of Iron Founding.

Our correspondents must excuse our naming particular brands of pig iron as either best or worst. Nor can they reasonably expect us to employ time and space which our readers expect to be devoted to matters more or less interesting to all, to teaching the way to escape a particular and not very uncommon difficulty in iron foundry work. If Messrs. Beger & Co. will bear steadily in mind the general principles that almost all fractures in cooling are produced either by *unequal* contractions along a line, due to sudden alteration of dimensions, or to *constraint*, preventing, or tending to prevent, contraction, and will apply these to their own difficulty, they will probably find the way out of it for themselves. One word more; the naming of 'brands' really goes for nothing, almost any sort of iron may have any brand. The *iron* must be judged of as *seen*, not the brand.—ED.]

TO CORRESPONDENTS.

W. S., Leicestershire.—Dr. Percy's excellent work on "Iron Manufacture," will give you the latest and most reliable information.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

THE ROYAL SOCIETY.

ON UNIFORM ROTATION. By C. W. SIEMENS, F.R.S., Mem. Inst. C.E.

AMONGST the means at our disposal for obtaining uniform rotation, there is none for which the same degree of accuracy can be claimed as that which distinguishes the vibrating pendulum, or the oscillating spring-wheel of the common watch; yet there are many purposes, both in physical science and in the mechanical arts, for which smaller subdivisions of time than the period of one oscillation are matter of considerable importance and which can only be measured by uniform rotation.

Conical Pendulum.—The apparatus by which continuous rotation of the greatest regularity has hitherto been obtained, is the conical pendulum, which was first applied by James Watt to regulate the speed of his engines, and which has since received further development in the instrument known as the chronometric governor.

On examining into the principle involved in the conical pendulum, it will be found that the time t of its rotation is dependent upon its length l, and on the angle α which it makes with its vertical axis of rotation, which dependence is expressed by the formula

$$t = \varphi\sqrt{l\cos\alpha},$$

the coefficient φ being a function due to gravitation. The value of t being dependent upon α, it follows that "*uniform rotation of a conical pendulum cannot be obtained except on condition that the angle of its rotation remains constant.*"

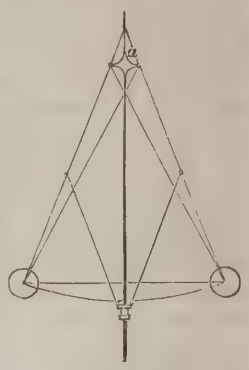
Watt's Governor.—In the case of Watt's centrifugal governor, the angle of rotation of the pendulum varies with every change in the relative condition of power and load on the engine, and the change of the angle is, indeed, taken advantage of to close or open the steam-supply valve. In order to close the steam (or throttle) valve the angle of rotation has to be increased, which necessitates a corresponding increase of the engine's velocity; on the other hand, an increase of the valve orifice must be consequent on a reduction of the speed of the engine.

Considering this dependence of the action of the instrument upon permanent change of speed of the engine, the name of "governor" seems inappropriate, the instrument being, in fact, only a "moderator" of the amount of fluctuation to which the engine would be subjected to without its agency. The amount of these fluctuations depends, in a great measure, upon the mechanical construction of the instrument, which is, generally speaking, very objectionable, inasmuch as the pendulous arms are mostly suspended at points beside the common axis of rotation, giving rise to an increased variation of time for a given change of angle; the reason being that the true pendulous length has to be measured from the point of intersection of the pendulums or rods with the axis of rotation, which point descends as the angle increases, causing the pendulous length to diminish at both extremities. A better result would be obtained if each pendulous rod were suspended from the point past the axis of rotation (as shown by dotted lines in fig. 1), causing the two rods to cross in the line of the axis at a point which would rise with increase of angle, and render the true pendulous length approximately uniform between certain limits.

The governor of Watt is, however, subject to another defect which does not admit of an easy rectification, and which consists in its want of power to operate on the steam valve at the moment when the equilibrium between the power and load on the engine is disturbed. It will be seen that while the engine proceeds uniformly, gravitation and centrifugal force must be in equilibrium as regards the governor balls, but at the moment when, for instance, a portion of the load on the engine is removed, steam power will be set at liberty for accelerating the fly-wheel. This acceleration proceeds in accordance with the well-known gravitation laws until the increase of centrifugal force imparted to the governor balls suffices to overcome the friction of the valve and its mechanical connections, which are not inconsiderable. In the meantime the speed of the engine will have been increased to an extent considerably beyond what is required in order to maintain the valve in its new adjustment; the action of the governor, when it does not take place, will therefore be excessive, and a series of fluctuations in the speed of the engine must follow before the proper readjustment of its valve can be effected.

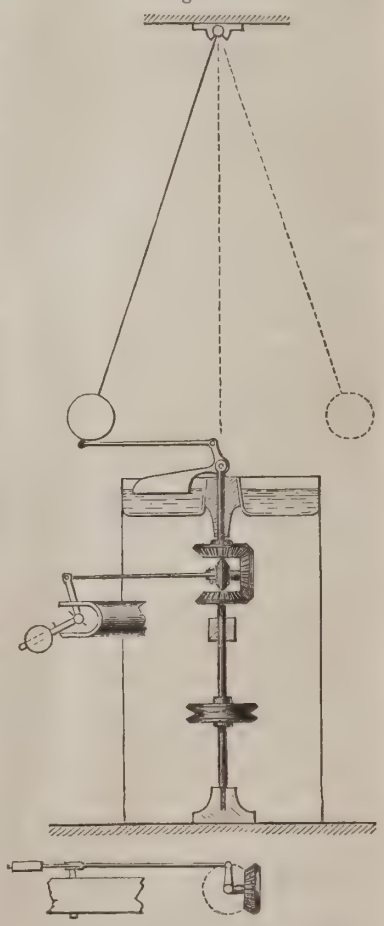
Chronometric Governor.—Impressed with these imperfections in Watt's centrifugal governor, I proposed, twenty-three years ago, in connection with my brother, Werner Siemens, a governor based also on the conical pendulum, which in this case was to be independent in its action of change in its angular rotation, and, moreover, was to be provided always with a store of power ready to overcome the resistance of the valve at the first moment when the balance between the power and load of the engine was disturbed. This instrument (the chronometric governor) has been applied with success in many cases where engines were required to work with great regularity under varying conditions of load; it has also received an interesting application by the Astronomer Royal for regulating astronomical and chronographical instruments, proving the high degree of precision of which it is capable.

Fig. 1.



The leading idea involved in this governor consisted in providing a conical pendulum in *uniform rotation*, and in establishing a *differential motion* between it and the wheel driven by the engine, which differential motion was made to act upon the source of power of the latter. If this idea could be carried out, it was evident that the engine, or machine to be governed, must suit its motion closely to that of the independent rotating pendulum, because the least retardation on its part must immediately result in an enlargement of the valve orifice (it being understood that an increase of available power is always obtainable), and the least motion in advance of the pendulum must automatically reduce the source of power. This action would be effected instantly, notwithstanding a considerable resistance in the valve, because the weight of the pendulum in rotation represents, in this case, a store of power, inasmuch as its angular velocity would have to be suddenly checked or increased as the case may be, unless the valve obeyed to the first appearance of a differential motion. In order to realize these conditions, it was necessary to maintain the conical pendulum in question at a uniform angle of rotation, notwithstanding the changes of driving or sustaining power which must necessarily arise through its action upon the regulating valve of the engine; and this could only be accomplished by providing the means of destroying or absorbing any excess of driving power beyond what was necessary to overcome the friction of the instrument, and which must tend otherwise to increase its angle of rotation. On the other hand, a surplus of driving power had to be provided to prevent an occasional collapse of the pendulum in opening the valve. The sustaining or driving power of the pendulum was obtained in taking advantage of the differential motion, a weight being attached to a horizontal lever upon the throttle valve spindle, which, in exerting a pressure of the differential wheel against the two principal wheels, caused an impulse to be given to the one connected with the pendulum, whereas the third wheel was driven by the engine in the direction proper to raise the weight continually. The excess of driving power imparted to the pendulum was destroyed by calling into action a friction between two solid substances at the moment when the angle of rotation had reached its intended maximum; or aliquid resistance was introduced, such as a fan, rotating with the pendulum, being dipped into a bath of mercury or other liquid, at the moment when the extension of the pendulum was attained (see fig. 2).

Fig. 2.



The governors constructed on this principle are remarkable for their instantaneous action upon the supply valve of the engine, when a sudden disturbance of the balance between load and power takes place; and they possess also, to the fullest extent, the power of maintaining the regulated machine at the same speed, when the load reaches its maximum, as when it is at its minimum. In the hands of the Astronomer Royal the uniformity of motion obtained by the use of this governor approached indeed that of an ordinary chronometer, yet it is not free from objections resulting from the delicate adjustment and frequent attention requisite to maintain it in good

working condition. In its application to the regulating of physical apparatus it has, moreover, been found that the conical pendulum is apt to fall into elliptical rotation, whereby the subdivisions of time below the half second become inaccurate.

Foucault's Governor.—Monsieur Foucault, of Paris, has treated the same question in a different manner, substituting for the friction between solids, or of solids against fluids, which we employed to fix the angle of rotation of the conical pendulum, the varying resistance of an air-propeller, according to the amount of area for the escape of air, which area he regulates by means of the angular elevation of his conical pendulum. The conical pendulum he employs is mounted in the manner of a Watt's governor of the best construction, which renders his apparatus portable, and therefore convenient for general purposes, while, on the other hand, it appears to depend for its correct action upon the perfect condition of many mechanical details.

Some months since an idea suggested itself to me which, while it furnishes the elements of a very general and complete solution of the problem under consideration, appears to possess also a separate scientific interest, which chiefly induces me to bring the subject before the Royal Society.

Liquid in Rotation.—If an open cylindrical glass vessel or tumbler containing some liquid be made to rotate upon its vertical axis, the liquid will be observed to rise from the centre towards the sides to a height depending on the angular velocity and the diameter of the vessel. As soon as the velocity has reached a certain limit, the liquid will commence to overflow the upper edge of the vessel, being thrown from it in the form of a fluid sheet in a tangential direction. If the velocity remain constant from this moment, the overthrow of the liquid will be observed to cease, although the liquid remaining in the vessel will continue to touch the extreme edge or brim. Supposing that the velocity of the vessel be now diminished, the liquid will be observed to sink, but will rise again immediately to its former position when the rotation returns to its previous limit of angular velocity. This velocity is the result of the balance of two forces acting on the liquid particles, namely, gravity and centrifugal force.

It is a well-known fact that the curvilinear surface produced by a liquid in rotation is that of a paraboloid, the parameter of which is expressed by $\frac{g}{w^2}$, and the curve itself therefore by the formula

$$y^2 = \frac{2g}{w^2}\, x, \quad \ldots\ldots\ (\text{I.})$$

x signifying vertical distance from the apex,
y the corresponding horizontal distance from the axis of rotation
w the angular velocity of rotation, and
g acceleration by gravity in one second.

In this formula there is no factor denoting the density of the liquid, which proves that the point to which the liquid is raised by a given angular velocity is independent of the specific gravity of the liquid employed.

By substituting for y the radius r of the rotating cup at the brim, and for x the height h of the brim above the lowest level of the liquid, we may write the foregoing general formula as follows,

$$h = \frac{r^2 w^2}{2g}, \quad \ldots\ldots\ (\text{II.})$$

and

$$w = \frac{\sqrt{2g\,h}}{r}, \quad \ldots\ldots\ (\text{III.})$$

two convenient formulæ for determining the height to which liquid will rise when the diameter of the rotating vessel and its angular velocity are given, or for determining the angular velocity due to a given height and diameter, it being understood that the values of gr and h must be expressed in the same unit of length.

If it is desired to determine the number of revolutions per second n, instead of the angular velocity w, we may put

$$n = \frac{w}{2\pi},$$

and in putting this value for w $(=2\pi n)$ into the last formula, we have

$$n = \frac{\sqrt{2g\,h}}{2r\,\pi}. \quad \ldots\ldots\ (\text{IV.})$$

These formulæ are applicable to vessels of every possible external form rotating upon their vertical axis, and to every possible liquid, but they are based upon the supposition that the liquid is raised by rotation to the upper edge or brim of the vessel, a condition which it may appear at first sight difficult to realize for practical purposes.

If the production of uniform rotation be the object in view, it is necessary that the liquid in the rotating vessel should always be at the point of overflow, although the driving power might vary considerably, and that all surplus driving power should be absorbed by other work than that of accelerating the rotating vessel, also that the stock of liquid within the vessel should never diminish. I hope to prove by the following demonstration that these various conditions can be fulfilled by suitable mechanical arrangements resulting in the construction of a simple and efficient instrument, which is represented by fig. 1, and which has survived the ordeal of experimental proof.

Liquid Gyrometer.—The rotating vessel consists, in this case, of a cup, C, open both at the top and bottom, but widest at the top, the sides being made to close in towards the bottom in a parabolic curve analogous to that formed by the liquid in rotation. This cup contains upon its inner surface three or four radial ribs which unite in a central boss, by which the cup is supported upon the spindle, S. This support is not an absolute one, but the spindle is armed with a screw-thread of rapidly ascending path, into which the screw-threads upon the inner surface of the boss are made to fit; a fixed connection between the driving spindle and the cup, C, is established by means of a spiral spring, E, one end of which is fastened to the projecting end of the spindle, S, and the other to the cup. Before this spring is fixed, it is drawn out longitudinally to such an extent as to balance the weight of the cup, which latter may therefore be said to float upon the screw-threads without exercising any pressure upon the same. The upper support of the spindle, S, is a boss projecting from the bottom of a cylindrical vessel, B, of glass sides and glass-domed top, which completely incloses the cup, C, while it renders its action visible: this outer vessel is filled with liquid to such a height as to submerge the lower edge of the cup. Rotation of the liquid in the outer vessel is prevented by radial ribs upon its bottom surface; and upon the external surface of the rotating cup, C, two concentric projections are provided, one at the upper edge, and the second near the surface of the outer liquid, for the purpose of throwing off some liquid which would otherwise be apt to adhere to the external surface of the cup, in defiance of centrifugal force, and interfere slightly with its proper action.

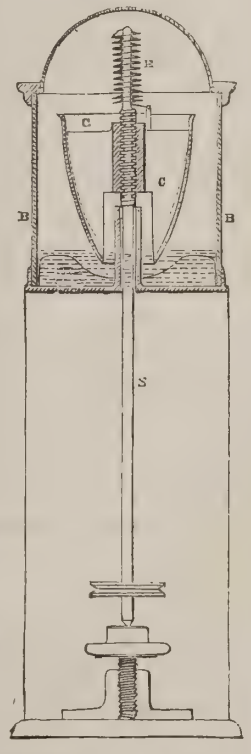
Rotation being imparted to the shaft, S, and the cup, C, by clockwork or from any other source, the liquid at the bottom of the cup will be acted upon by centrifugal force and rise upon its inner sides, while additional liquid will enter from without and maintain the apex of the liquid curve nearly on a level with the surrounding lake. At the moment when the liquid in rotation touches the upper edge of the cup, the speed should be such as is determined by the formula

$$n = \frac{\sqrt{2g\,h}}{2r\,\pi},$$

in which h may be taken for the height of the brim of the cup above the lake surface; but considering that the power necessary to maintain the cup at its velocity, after the liquid has been raised to its upper edge, is exceedingly small, because no fresh material has to be put into motion, it would be practically impossible to prevent further acceleration. In order to make sure that the liquid will not fall below the brim of the rotating cup, an excess of driving power must be applied, and that excess must be disposed of otherwise than in producing further acceleration of the cup. This is accomplished by means of a continual overflow of a thin sheet of liquid, which is projected against the sides of the outer vessel and falls back into the lake at the bottom, whence a similar quantity of liquid penetrates into the cup, to be also raised by its rotation and projected over its edge.

The power absorbed in raising and projecting the liquid must be strictly proportionate to the quantity of liquid so acted on in a given time, or to the thickness of overflow, provided the condition of uniform velocity be realized; but the velocity of the cup depends upon the height to which the liquid has to be raised, and must therefore be increased in order to raise the liquid column above the brim of the cup. The necessary increase of velocity to produce such an overflow is not great, considering that the height of the liquid column increases in the square ratio of the velocity, and may be neglected in all cases where only approximate results are required, or where variations in the driving power are comparatively small; but no high degree of accuracy could have been claimed for this instrument unless the following compensating action had suggested itself:—

Fig. 3.



Automatic Dip of Cup.—We have assumed hitherto a rigid connection between the cup and its driving spindle, and unless the cup does overflow, we are, indeed, justified in this assumption, the spring, E, being too rigid to yield to the resistance of the cup in motion when no work is performed. With an increase of power the resistance of the cup also increases, and an overflow of liquid proportionate to the power is produced; the connecting spring, E, must yield, at the same time, proportionately to the torsional resistance thus created, and in the same ratio the cup will descend upon the helical surface which serves for its guide. While, therefore, on the one hand, the h of our formula increases with the overflow, it is diminished in the same ratio by the descent of the cup, both depending directly upon the driving power. In so adjusting the stiffness and length of the spring that the one action equals the other for any given increase of power, it must equal it also for other amounts of increase within reasonable limits, and *strictly uniform rotation must be the result.* The "reasonable limits" to this automatic adjustment are imposed by the restricted orifice through which the liquid has to penetrate into the cup, and also by the range of action of the spring, for which the law of Mariotte is applicable. Experiments, to be hereafter described, have shown that the driving power may be varied between wide limits without producing any sensible variation of speed. The final adjustment of the instrument to the normal velocity required is, moreover, easily effected by raising or lowering the cup while it is running, for which purpose the lower end of the upright spindle, S, is supported in the axis of an adjusting screw, E, as will be seen by inspection of fig. 3.

Range of Power Increased.—The range of power through which uniform rotation can be obtained, may be further increased by an arrangement which is represented in figs. 4 and 5, and which consists in arresting the liquid projected over the edge of the cup by a belt of fixed vanes, M, whence it drops through the zone of rotating radial of the vanes, L, which again impart tangential motion to it at the expense of the superfluous driving power of the cup of which they form part. It is hardly necessary to add that these fixed and rotating vanes only *increase the range of power of the instrument, without in any way affecting its rate of rotation,* and that a second set of fixed and rotating vanes might be added with the same effect as the first. Although the rotating cup represented in figs. 4 and 5, is not provided with the automatic dip, it is equally evident that the fixed and movable vanes do not preclude that arrangement, which is only dispensed with in such cases where great uniformity of motion is not required.

An interesting application of such a "Liquid Gyrometer," as this instrument may appropriately be called, would be that of obtaining synchronous motion at different places connected by a telegraphic wire, for philosophical or telegraphic purposes; but in order to test its fitness for such purposes, I have constructed a clock of which it constitutes the regulating principle, the moving power being obtained by electro-magnetism.

(*To be continued.*)

"NOTE ON MR MERRIFIELD'S NEW METHOD OF CALCULATING THE STATICAL STABILITY OF A SHIP." By W. J. MACQUORN RANKINE, C.E., LL.D., F.R.S.

On the 24th of January, 1867, a paper was read to the Royal Society by Mr. C. W. Merrifield, F.R.S., Principal of the Royal School of Naval Architecture, showing how, by determining the radii of curvature of the locus of the centre of buoyancy or "metacentric involute" of a ship in an upright position and at one given angle of inclination, a formula may be obtained for calculating to a close approximation her moment of stability at any given angle of inclination, on the assumption that the metacentric involute can be sufficiently represented by a conic.

It has occurred to me that the latter part of the calculation in Mr. Merrifield's method might be simplified by assuming for the approximate form of the metacentric involute, not a conic, but the *involute of the involute of a circle;* the locus of its centres of curvature, or "metacentric evolute," being assumed to be the involute of a circle.

The involute of the involute of a circle is distinguished by the following property. Let r be the radius of the circle, ϱ_0 that radius of curvature of the involute of the involute which touches the involute at its cusp, and ϱ another radius of curvature of the same curve making the angle θ with the radius ϱ_0; then

$$\varrho = \varrho_0 + \frac{r\theta^2}{2} \quad . \quad . \quad . \quad . \quad . \quad . \quad (1).$$

Having found, then, the radii of curvature of the metacentric involute in an upright position, and at a given angle of inclination θ_1, let ϱ_0 and ϱ_1 be those radii respectively; then make

$$r = \frac{2\,(\varrho_1 - \varrho_0)}{\theta_1^{\,2}} \quad . \quad . \quad . \quad . \quad . \quad (2).$$

This will be the radius of the required circle; and its positive or negative sign will show whether it is to be laid off downwards or upwards from the metacentre. For any given angle of inclination the radius of curvature of the metacentric involute will be given by equation (1), which may also be put in the following form:

$$\varrho = \varrho_0 + (\varrho_1 - \varrho_0)\,\frac{\theta^2}{\theta_1^{\,2}} \quad . \quad . \quad . \quad (3).$$

Let δ be the depth of the ship's centre of gravity below her metacentre, and p the perpendicular let fall from that centre of gravity upon the radius of curvature of the metacentric involute at any given angle of inclination θ; then

$$p = (\delta - r)\sin\theta + r\theta \quad . \quad . \quad . \quad (4);$$

and the moment of stability is

$$p \times \text{displacement} \quad . \quad . \quad . \quad . \quad . \quad (5).$$

It is obvious that the condition of *isochronous rolling* is that $\delta - r = 0$; that is to say, that the centre of the circle which is the evolute of the metacentric evolute shall coincide with the ship's centre of gravity: a proposition already demonstrated by me in a paper read to the Institution of Naval Architects in 1864, and published in their Transactions, vol. v. p. 35.

[*Postscript.*—Received March 11, 1867.]

Since the above was written, I have been informed by Mr. Merrifield, to whom I had communicated my proposed modification of his method, that it has been tried at the Royal School of Naval Architecture and found to answer well.

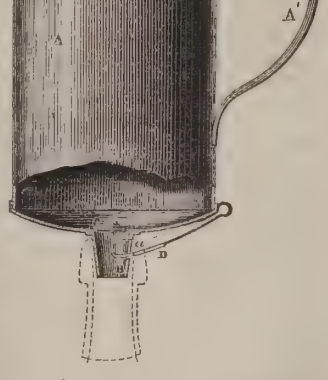
MONTHLY NOTES.

MARINE MEMORANDUM.

Crossing the Atlantic on a Raft.—The *New York Herald*, of June 4, says,—"The raft *Nonpareil* is to sail for Europe on Tuesday next, with a view to demonstrate the safety and security of a floating structure built on the principle of a life-saving apparatus. The *Nonpareil* is composed of three parallel air cylinders, shaped like cigars, which form what in a vessel would be called the hull. These cylinders are 25 feet long and 26 inches in diameter, being composed of gutta-percha encased in Russia O duck, the outer casing being less in circumference than the inside air chamber, and thus receiving the greatest strain. It is to be sailed by Captain John Mikes (an officer mentioned honourably in the *Herald* upon the occasion last fall of a disaster to the *Santiago de Cuba*) and George Miller and Henry Lawson, seamen, who have faith in her buoyant power, having seen it tested on the coast in such a manner that they regard a trip across the ocean as a possibly agreeable incident, but entirely without danger. They will carry mostly canned provisions, although a cooking apparatus is on board, but it is not likely to be in a condition for use except in fair weather. The raft is at present, with a view to its transatlantic trip, schooner rigged, being in addition provided with two centre boards for better security in a heavy sea, although it is said to be a matter of impossibility to either upset or swamp it. The raft carries twelve india-rubber water casks, six strapped on each side, which, if necessary, are able to do duty as life preservers, being of buoyant capacity, sufficient, it is claimed, to float nine men each. The *Nonpareil* is not a new invention, rafts of similar construction—of course without the extra rigging that has been set up for the ocean trip—being in practical use as a matter of security on board several vessels belonging to our steamship lines and the monitor *Miantonomoh*. Packed for conveyance, the air being exhausted from the chambers that compose the hull, the raft occupies a space of about 12½ feet lengthwise, with 60 inches of circumference."

The Silver Mint of Japan.—If we could gain admission to the Silver Mint at Yeddo we should see the following process continually going on. A lump of silver of the necessary fineness, obtained either from the government mines or by melting down Mexican dollars, is placed in an iron ladle and reduced to a molten state by means of a charcoal fire and a pair of blacksmith's bellows. It is then poured into a mould, from which it is taken out in the shape of thin rectangular bars, which are immediately thrown into a tub of cold water. On being taken out, a man seated on the ground shears off with a pair of large fixed scissors all jagged pieces adhering to the angles. They are now handed to another man, who weighs them one by one, and a piece is cut off, if necessary, to reduce the bar to its proper weight. The next process is that of dividing the bar by a fixed pair of shears into eight equal portions of the size of ichibus; this is done by a workman cutting it as accurately as his practised eye will enable him, and his work is tested by weighing, light pieces being rejected, and the heavy ones reduced to their proper weight by the scissors. The pieces are now heated white hot in a charcoal fire, plunged into water, boiled, and washed in a kind of brine, from which they come out with a moderately bright surface. They are next very slightly milled on the two sides, and more deeply on the edges, by means of a milled hammer. They are now ready for stamping. A man places one of the pieces on a stationary die, and lays on the top the other die; a second man, armed with a huge hammer, gives one blow on the upper die, and the coin is struck. The blows are dealt in rapid succession, and the whole scene reminds one of a blacksmith's shop. Boys now punch small stars on the edges by means of chisels and hammers. The coins are weighed one by one for the last time, and the light ones rejected. The imperial stamp is added by means of another stamped chisel and mallet, and the coins are complete. They are rolled up in paper packets of a hundred; each packet is weighed, and marked with a seal, which serves as a guarantee of its contents, and gives it currency as a hundred ichibus. While every operation is performed in this primitive manner, perfect order prevails in the establishment. Every man goes through his portion of the work in silence and with the regularity of clockwork, and many evince considerable skill. There are about 300 hands employed in the building. When the men enter in the morning they are made to divest themselves of their own clothes, and put on others belonging to the Mint. At the end of the day's work a gong sounds, when the somewhat curious spectacle is presented of 300 men springing from the ground on which they have been seated, throwing off their clothes, and rushing, a naked throng, to one end of a yard. Here they pass through the following ordeal, in order to prove that they have no silver on them:—Their back hair is pulled down and examined; they wash their hands and hold them up to view; they drink water, and then holloa; and lastly, they run to the other end of the yard, clearing two or three hurdles on their way; after which performance they are allowed to put on their own clothes and depart. Mr. Sydney Locock, her Majesty's secretary of legation, from whose report of this year these statements are taken, believes that the Mint has been only twice entered by foreigners, and states that the apparent absence of all restrictions with regard to touching and handling the coins points to the probability that it is not often open to the public; but he remarks that, even if it were, the manners and customs of the country are not such as would preclude a mixed assemblage of visitors going over it and remaining to the end. The quantity of silver being coined daily at the beginning of this year was 50,000 momme, which, at the rate of 2·3 momme to the ichibu, would give a daily total issue of over 21,000 bus, or about 1500*l.* The whole of these are produced by the simplest manual labour, unaided by a single piece of machinery.

Measuring Filler.—An exceedingly cheap and simple article whereby liquids may be readily measured and at once decanted into a bottle or other narrow-necked vessel, without the necessity for using a separate funnel or filler, has recently been registered by Mr. John Mourant, of Gronville, Jersey. The engraving represents a full-sized elevation, showing the lower part in section of the measuring filler, adapted to hold about one pint, but which may, of course, be constructed of all sizes, according to the different measures required. The vessel, A, may be made of tin plate or other material, and provided or not with a handle, A′, and legs or supports as desired, such parts forming no part of the design; but at the bottom of this vessel there is provided a nozzle, B, for insertion into the neck of a bottle or other like vessel, to receive the measured liquid. This nozzle, B, is closed by a valve, C, which is held down upon its seat by a blade spring, D, secured at one end to the valve, and at the opposite end to the bottom or side of the vessel, as shown in the engraving; a slot, *a*, being made in one side of the nozzle to allow of the passage of the blade spring. In using this measuring filler the liquid to be measured is introduced in the usual way, the valve, C, being held down upon its seat; but when the liquid is to be decanted into a bottle, for example, as shown by the dotted lines, the nozzle is inserted into the neck and the vessel pressed down, so as to cause the lip of the bottle neck to press against the spring, D, and elevate and open thereby the valve, C, when the contents of the vessel, A, will at once run into the bottle. On removing the vessel, A, the valve closes again, leaving the measure ready for a fresh charge. The parts of this design which are not new or original as regards the shape or configuration thereof, are those marked A and A′.



Waterproof Dressing for Fabrics and Yarns.—M. Fortier, of Lyons,

has proposed a waterproof dressing for fabrics and yarns, which consists in steeping the fabric or yarn in paraffine or sperm, dissolved in alcohol or benzole. After wringing the goods, and if necessary passing them through a hydro-extractor, in order to expel the superfluous solution, the materials thus treated are allowed to dry. When practicable, instead of dissolving the paraffin or sperm in alcohol, the inventor proposes to immerse textile fabrics in a bath of one of those substances maintained in a liquid state by heat. The process may be employed either alone or in combination with the waterproofing process usually adopted.

Priming Preventor.—A simple and ingenious contrivance has been recently invented by M. Lugnes for preventing priming or the discharge of water with the steam in the steam pipes of boilers. The apparatus consists of a short cylinder placed at the top of the horizontal part of a steam generator with its axis disposed at right angles to that of the axis of the boiler. The steam pipe proceeding from the dome opens tangentially into the cylinder through one side. The outlet pipe is forked, each branch opening into the cylinder in the centre of the two ends thereof. A fourth opening made in the bottom of the surface of the cylinder communicates with a pipe which descends to the bottom of the boiler. When the cocks of the steam pipe are opened the steam entering the cylinder under pressure in a tangential direction acquires a rapid rotatory or whirling motion, and escapes by the two central openings at the ends. During this gyratory motion the drops of water conveyed along with the steam into the cylinder are by centrifugal force carried towards the sides and accumulate there. The water will, therefore, escape through the vertical pipe which proceeds from the bottom of the cylinder, and return to the boiler; whilst the dry steam passes through the pipes fixed to the centre of the cylinder ends, whence it is conveyed to the engine.

The Aniline Dyes.—A new red has been obtained by Coupier, by a combination of two of the hydro-carbide bases of coal tar, which he has decided to be incapable of yielding a colour in their separate condition. It is named *toluen red*, and is pronounced the richest red yet known. The so-called aniline dyes are among the most beautiful results of chemistry. The series already includes and rivals the colours of the rainbow, and Coupier's analyses promise indefinite varieties of beauty to come. Beginning with the admired varieties of red and purple, such as *mauve*, *magenta*, &c., additions like that above named have followed, including the splendid green called verdine, unchanged by candle light, a blue as clear as opal or the Italian sky, a good yellow, and a fair black. The intensity of these colours is shown in the fact that one grain of magenta in 1,000,000 of water gives a good red, one in 10,000,000 a rose pink, one in 20,000,000 gives a blush to the water, and one in 50,000,000 a reddish glow. Aniline is, however, but a modification of one of a variety of hydro-carbides constituting the very variable bases of benzine and coal tar, and of which some combination is supposed by the investigator above referred to, to be necessary to the production of colours. M. Coupier has been engaged in the endeavour to realize industrially the isolation and management of these bases, in order to establish methods for uniform results; with the above instalment of theoretical and practical success. The rectified naphtha is resolved into benzol which makes aniline, toluen which makes tolouiden, xylen and hence xyleden, and a number of other distinct hydro-carbides, the possible compounds of which with each other and with oxygen, &c., when fully ascertained, will probably yield a complete and uniform series of dyes before which the old vegetable and mineral dye stuffs will rapidly pass into disuse.

Coal in India.—In the last published Part of *Memoirs of the Geological Survey of India* there is good news for those persons who are looking forward with alarm to the time when all our coal shall be burnt up, in the fact that plenty of coal can be had in India for the digging. In the valley of the river Damoodah, comprising more than 1200 square miles, there are immense stores of mineral wealth, chiefly coal. Some of this coal is of such good quality that it will be used for the manufacture of gas without admixture of English coal. Its excellence has long been known to the natives, who travel great distances to fetch it away. Dr. Oldham, superintendent of the Geological Survey of India, estimates that in the Jherria coal-field alone, which is not a sixth of the whole, there are 465 million tons of coal.—*Athenæum.*

The Lago Maggiore.—The Italian papers continue to give very interesting accounts, in a geological sense, of the land convulsions on the borders of the Lago Maggiore. Some time ago a small village on the shores of this water disappeared within the bosom of the lake, its immersion being caused by an extensive land-slip. It now appears that, for several months, the region adjacent to the Tyrolean Alps, to the Lago Maggiore, and the Lago di Guarda, has been subject to a series of convulsions, recurring at periodical intervals, by which the inhabitants have been kept in a state of great apprehension. The shores of the latter lake have been upheaved for a space of 10 miles by violent oscillations, and enormous masses of stone and earth continually fall from Monte Balbo, occasioning the utmost consternation among the inhabitants of the valley.

Meteoric Iron.—A catalogue has been published of the meteoric stones and meteoric irons in the Museum of the Geological Survey at Calcutta. Of the stones there are 137 specimens; of the irons, 90: a collection scarcely to be matched in the world. When the arrangement shall be completed for bringing together under one roof the "Indian Museum," to comprise the collections of the Asiatic Society of Bengal as well as the foregoing, the number of specimens will be multiplied.

Artesian Wells in Algeria.—Twenty-three years ago the French colonists of Algeria made their first attempts to sink artesian wells in their newly-acquired territory; but after boring in two places in the province of Oran to a depth of 98 and 176 metres without striking water, the attempts were abandoned. In 1856 operations were resumed by the military corps of engineers, and from that date, with two or three exceptions, every boring has succeeded; and at the end of 1864 seventy-five wells were flowing and delivering 4,200,000 litres of water every hour, or 100,000 cubic metres a day. The water is limpid and drinkable, but generally a little brackish. The effect of such a supply on the social life and industry of the country may be imagined. A village and date-plantations rise up around very well, and the natives, having something to lose, prefer peace to predacity. Thirty-five of the wells are in the Ouled Rir district, which stretches far to the south. The deepest well is 175 metres, the shallowest 29 metres, and the total of all the borings amounts to 6628 metres. The entire cost, defrayed by a tax on the natives, was 400,000 francs. Among the material results, we are informed that 150,000 date-trees have been planted in the Ouled Rir district alone, besides fruit-trees of other kinds, and more than 2000 new gardens have been formed. We may expect that these beneficial operations will be continued, for four boring brigades have been established, all well provided with implements, for the purpose of systematic exploration, and to sink wells in places likely to yield water. Guided by years of experience, their failures are now but few, and year by year their knowledge of the local hydrography, surface and subterranean, becomes more complete.

Meteorology at the Cape.—The Commission appointed to establish a system of meteorological observations for the colony of the Cape of Good Hope, have published their first report for the years 1861 to 1865 inclusive. Barometers, thermometers, and bulbs for solar radiation were placed at twelve different stations —one of the twelve being Antananarivo, in Madagascar—and twenty-two rain-gauges were distributed; and though some of the instruments have been broken, and the records interrupted, the work appears on the whole to be making satisfactory progress. From the tables of observations published with the Report any one interested in the subject can ascertain the readings of the instruments, the direction of the wind, and the rainfall at the several stations, and compare the weather of one part of the colony with another. If the Commission continue the publication of their annual returns, they will aid the cause of meteorology, and throw light on the atmospheric phenomena which occur in a low southerly latitude. It is worth remark that they announce on the first page of the present Report, that the statement published in 1864 as the report of the meteorological commission was not theirs, but was printed without their knowledge or sanction.

Mr. Graham and the Stars.—The *Athenæum* says:—"The Master of the Mint has actually given us a message from the stars! It occurred to Mr. Graham that, by investigating a certain class of metals of a 'soft colloid description,' such as native iron, platinum and gold, the gases they give off could be taken as evidence of their origin. The gas shut up in a meteorite would be derived from the atmosphere through which the meteorite passed when last in a state of ignition. A specimen of the well-known meteoric iron of Lenarto, when properly heated, and tested by a Sprengel aspirator, gave off three times its volume of hydrogen gas; malleable iron, on the contrary, can scarcely be impregnated with more than one-half its volume of the same gas. The inference, therefore, is, that the meteoric iron came from a very dense atmosphere of hydrogen gas, which atmosphere, says Mr. Graham, we must look for beyond the light cometary matter floating about within the limits of the solar system. That hydrogen is a constituent of a considerable number of the fixed stars has been ascertained by recent spectrum observations; hence we may fairly assume that the Lenarto iron has brought to us the hydrogen of the stars."

Tunnelling by Diamond Tools.—It is stated that the tool used in boring the rock for the tunnel at Port Vendres consists of black diamonds set in a revolving ring, which is gradually set up before the face of the work. The application is said to belong to M. Fichet, and that the rate of progress in hard rock is 4 feet per hour.

APPLICATIONS FOR
PROVISIONAL PROTECTION FOR INVENTIONS
UNDER THE PATENT LAW AMENDMENT ACT.

☞ When the city or town is not mentioned, London is to be understood.

15th April, 1867.

1118 Joseph Oakden, Congleton, and Joseph Pickin, Buglawton—Enamelling metals
1119 W. R. Lake, Chancery Lane—Shoes for horses.—A com.

16th April, 1867.

1120 J. W. Breakell, Manchester—Windows
1121 J. E. Hodgkin, Liverpool—Manufacture of oakum
1122 James Hargreaves, Appleton-within-Widnes—Manufacture of steel
1123 George Simpson, Glasgow—Working mining tools
1124 Daniel Rankin, Greenock—Oscillating steam engines
1125 E. B. Nunn and J. P. Nunn, Royston—Separating corn and seeds
1126 John Lewthwaite, Southwark—Knife-cleaning machines
1127 T. W. Gray, Limehouse—Lightning conductors
1128 William Weild, Manchester—Winding yarn
1129 E. C. Prentice, Stowmarket, and T. Richardson, Newbiggin—Treating gun cotton
1130 Robert Roby, Bury St. Edmunds—Ploughs

17th April, 1867.

1131 Samuel Shore, Rochdale—Spinning fibrous materials
1132 J. S. Brooks, Cambridge Villas—Colouring tobacco pipes
1133 Archibald Turner, Leicester—Elastic cords
1134 Robert Roby, Bury St. Edmunds—Sifting seeds
1135 J. W. Dalby and G. O. Chapman, Bradford—Winding yarns
1136 A. F. Wornum, Store Street—Pianofortes
1137 W. Cochrane, Northumberland—Breaking Minerals.—A com.
1138 T. Horsley, York—Fire-arms

18th April, 1867.

1139 John Scott, Oxford Street—Fire-escapes
1140 William Holding and James Holding, Wheelton—Looms
1141 Eduard Wolf, Fore Street—Pipes for smoking
1142 William Begg, Preston—Regulating the supply of air to furnaces
1143 Edward Lindner, New York, U.S.—Fire-arms
1144 J. E. Mellin and C. H. Ulbricht, Sherwood Street—Boxes for address cards
1145 George Ripley, Bradford—Colouring yarns
1146 William Wilkinson, Jarrow—Catching fish

20th April, 1867.

1147 William Kirrage, Bridge Road—Bricks
1148 A. E. Griffiths, Kensington—Pan for cooking omelettes
1149 John M'Kechnie, Glasgow—Applying concentrated heat
1150 John Millward, Birmingham—Brewers' mash tuns.—A com.
1151 T. V. Lee, Macclesfield, and C. E. Lankester, Peckham—Colours
1152 James Galloway and Thomas Settle, Bolton—Manufacturing spindles
1153 William Harrison, Winsford—Consuming smoke
1154 Levi Davis, Edgbaston—Hat guards
1155 John Petrie, Rochdale, and Reuben Ackroyd, Ovenden—Washing wool

1156 Samuel Cocker, Sheffield—Axles for carriages.—A com.
1157 Edward Howell and Thomas Hardy, Poole—Horse rakes
1158 R. H. Frith, Dublin—Measuring gas
1159 J. B. Roby, Featherstone Street—Substitute for whalebone
1160 John Atkinson, Leeds—Wheels
1161 W. G. Crossley, Cambridge—Velocipedes
1162 Henry Fassmann, Chancery Lane—Metal bands
1163 J. W. Cochran, Chancery Lane—Fire-arms

22nd April, 1867.

1164 John Peebles, Errol—Motive-power engines
1165 Cesar de Tivoli, Great Winchester Street Buildings—Needle rifle.—A com.
1166 Daniel Fryer, Carlton Square—Lamps
1167 Joseph Needham, Piccadilly—Fire-arms
1168 W. E. Gedge, Strand—Iron forks.—A com.
1169 W. E. Gedge, Strand—Galvanizing iron wire.—A com.
1170 J. B. Mannix, Limerick—Permanent way of railways.—A com.
1171 C. T. Hook and E. Hook, Snodland—Manufacture of paper

23rd April, 1867.

1172 Arthur Rigg, Chester—Grinding grain
1173 John Plews, Bucklersbury—Cartridges
1174 Elisha Leigh, Liverpool—Bowls and jugs
1175 D. Whittaker and B. Croasdale, Blackburn—Looms
1176 Joseph Westwood, Bow—Turrets
1177 W. R. Lake, Chancery Lane—Sugar machines.—A com.
1178 W. R. Lake, Chancery Lane—Centrifugal sugar machines.—A com.
1179 W. R. Lake, Chancery Lane—Refining sugar.—A com.
1180 S. J. Mackie, Bayswater—Burning petroleum
1181 A. V. Newton, Chancery Lane—Pumping engines.—A com
1182 Jesse Brickles, Manchester, J. S. Jackson, Pendleton, and W. S. Berry, Manchester—Production of designs upon fabrics

24th April, 1867.

1183 John Haworth, Manchester—Issuing tickets
1184 W. F. Wilkinson, Ely—Horse hoes
1185 James Smalley and Samuel Bridge, Liverpool—Mixing paint
1186 L. B. Bruen, Chancery Lane—Sewing machines
1187 Thomas Tivey, Derby—Narrow weavings
1188 C. F. Whateley, Birmingham—Distributing vapour
1189 J. D. Brickles, Valentine Road—Woven fabrics
1190 J. H. Johnson, Lincoln's Inn Fields—Peat charcoal.—A com.
1191 Thomas South, Southwark—Cooking apparatus
1192 W. R. Lake, Chancery Lane—Guiding horses.—A com.
1193 Frank Crossley, Manchester—Cutting india rubber

25th April, 1867.

1194 Theodore Lemielle, Valenciennes—Ventilation of mines
1195 George Gordon, Charing Cross—Drying moist substances
1196 W. R. Lake, Chancery Lane—Cutlery.—A com.
1197 S. L. Worth, Oxford Street—Sweeping carpets
1198 C. E. Brooman, Fleet Street—Destroying vegetable matters in wools.—A com.
1199 C. E. Wetton and W. Galsworthy, Grimsbury—Regulating the supply of liquids
1200 C. E. Brooman, Fleet Street—Preserving meat.—A com.
1201 John Raywood, Wentworth—Private indicator
1202 A. M. Clark, Chancery Lane—Self-acting tackle hook.—A com.
1203 John Millward, Birmingham—Steam engines.—A com.
1204 Hugh Smith, Much Hadham—Preparing turnips

26th April, 1867.

1205 E. G. Fitton and Somerville Dear, Leeds—Looms
1206 C. D. Abel, Chancery Lane—Pulverizing substances.—A com.
1207 J. W. Burton, Leeds—Treatment of fibrous material
1208 Tempest Booth, Ardwick—Keeping glues warm
1209 James Archibald, Coleman Street—Tents.—A com.
1210 J. H. Johnson, Lincoln's Inn Fields—Magneto-electric machines.—A com.
1211 A. M. Clark, Chancery Lane—Life boats.—A com.
1212 Emile Guenin, Henrietta Street—Preparation of mustard.—A com.
1213 William Clark, Chancery Lane—Electric telegraph apparatus.—A com.
1214 G. A. Huddart, Brynkir—Buttons
1215 W. E. Newton, Chancery Lane—Burning wool.—A com.
1216 L. B. Bruen, Chancery Lane—Shot cartridges
1217 George Pollard, Hayfield—Regulating the pressure of steam

27th April, 1867.

1218 J. W. Cochran, Chancery Lane—Improved level
1219 Joseph Moseley and Charles Moseley, Ardwick—Coverings for rollers
1220 Daniel Birkett, Carlisle—Fireproof floors
1221 John Cariss, Kilburn West—Locking railway signals
1222 James Dewar, Kirkcaldy—Spray producer
1223 John Speight, Bradford—Spinning worsted
1224 J. W. Lowther, Manchester—Lubricators
1225 Thomas Paton, Liverpool—Motive-power engines
1226 W. Crooke and T. Wrightson, Stockton-on-Tees—Hoists
1227 John Swinburne, Wenlock Street—Furnaces
1228 John Taylor, Whitehall—Seats and sofas
1229 Emile Guenin, Henrietta Street—Manufacture of manure.—A com.
1230 R. F. Chapman, Preston—Self-acting signal
1231 C. E. Brooman, Fleet Street—Cartridges—A com.

29th April, 1867.

1232 Thomas Watson, Scatcliffe—Beaming yarns
1233 J. F. Lawton, Micklehurst—Variation of colour
1234 George Davies, Serle Street—Stuffing boxes.—A com.
1235 Jacob Bird, Bromborough Pool—Buckets for pumps
1236 E. T. Hughes, Chancery Lane—Bobbins.—A com.
1237 P. J. J. Allibert, Paris—Steam boilers.—A com.
1238 J. H. Johnson, Lincoln's Inn Fields—Preventing access of insects to dwellings.—A com.
1239 M. A. F. Mennons, Southampton Buildings—Indicating the rise of water.—A com.
1240 Edward Waterman, Bristol—Boots and shoes
1241 James Combe, Belfast—Winding fibrous substances
1242 Robert Smith and M. B. Westhead, Manchester—Making up tapes
1243 Thomas Bell and T. L. G. Bell, Vitriol Works—Manufacture of manures

30th April, 1867.

1244 George Severn, Hampstead Road—Rails
1245 George Davies, Serle Street—Cutting millstones.—A com.
1246 Robert Booth and R. W. Booth, Dublin—Fret-sawing machine
1247 H. S. Swift, Peckham—Screw propeller
1248 R. W. Ridley, Birmingham, and J. Withers, Handsworth—Indicating measure taps
1249 Eli Deeley, Pelsall—Rolling hoop iron
1250 George Davies, Serle Street—Match boxes.—A com.
1251 Thomas Webb, Newington Butts—Sewing machines
1252 George Hodgson, Bradford—Power looms
1253 John Marshall, Wednesbury—Gun barrels
1254 A. M. Clark, Chancery Lane—Manufacture of sugar.—A com.
1255 Charles de Grelle, Basinghall Street—Fire-arms.—A com.

1st May, 1867.

1256 William Snell, Clement's Inn—Boots and shoes.—A com.
1257 Antoine Louet, Issoudun—Movable palisades
1258 W. E. Gedge, Strand—Mattresses, pillows, and cushions.—A com.
1259 J. J. Kraffert, Berlin—Self-acting repeating rifle
1260 Reuben Young, Redditch—Needle boxes
1261 Ferdinand Jossa, Fence Houses—Lubricators
1262 H. A. Clum, Euston Square—Indicating atmospheric changes
1263 John Howell, Creekmore—Chaff-cutting machines
1264 J. H. Johnson, Lincoln's Inn Fields—Welding, brazing, and puddling.—A com.
1265 J. H. Johnson, Lincoln's Inn Fields—Boots and shoes.—A com.
1266 J. H. Johnson, Lincoln's Inn Fields—Boots and shoes.—A com.
1267 J. L. Norton, Belle Sauvage Yard—Drying machines
1268 Samuel Newington, Ticehurst—Horticultural buildings
1269 E. B. Bigelow, Paris—Looms
1270 John Thomlinson, Carlisle—Fire-proof floors

2nd May, 1867.

1271 John Brown, Sheffield—Construction of fortifications
1272 Peter Salmon, Westminster—Making and holding gas
1273 James Lomax and John Lomax, Farnworth—Wagons
1274 H. A. Bonneville, Bayswater—Ribbon looms.—A com.
1275 H. A. Bonneville, Bayswater—Transmitting the hour by electricity to clocks—A com.
1276 H. A. Bonneville, Bayswater—Teaching writing.—A com.
1277 Auguste Brunier, Paris—Hat cover
1278 C. H. Collette, Lincoln's Inn Fields—Staircases.—A com.
1279 C. D. Abel, Chancery Lane—Administrative telegraphy.—A com.
1280 James Symth, Woolwich, and Samuel Kirby, Bedford—Musical instruments
1281 Frederick Walton, Wolverhampton—Infusions of coffee
1282 Charles Dutton, West Bromwich—Revolving screens
1283 G. A. J. Schott and J. S. Rosenthal, Bradford—Yarn
1284 Thomas Wood, Manchester—Safety valves
1285 J. H. Johnson, Lincoln's Inn Fields—Raising heavy bodies.—A com.
1286 Joseph Stuart, Ludgate Hill, and J. H. Smith, Hoxton—Sewing machines
1287 W. R. Lake, Chancery Lane—Nutmeg grater.—A com.
1288 J. F. Collins, New York, U. S.—Manufacture of alcohol
1289 Charles Ritchie, Brixton—Storing beer, wine, &c.

3rd May, 1867.

1290 Cléo Chevron, Paris—Figure weaving machinery
1291 H. W. Grylls, Dalston, H. Neville, Mile-End, J. W. Brooks, Victoria Park, and J. Holt, Hackney Road—Obtaining motive power
1292 A. M. Clark, Chancery Lane—Locking screw nuts.—A com.
1293 Ernest Krieghoff, Toronto—Spring mattresses
1294 J. H. Johnson, Lincoln's Inn Fields—Treatment of raw silk.—A com.
1295 John Heaton, Langley Mill—Converting cast iron into wrought iron and steel
1296 G. F. Millin and E. J. Potter, Bow Lane—Manufacture of parcel books
1297 John Holmes, Wylde Green—Beer engines
1298 Samuel Thacker, Sneinton—Knitted fabrics
1299 J. G. Rollins, Old Swan Lane—Fire-arms.—A com.
1300 John Ramsbottom, Leeds, and T. M. Pearce, Bradford—Turbines
1301 Thomas Crossley, Trafalgar Square—Portable lamps
1302 Thomas Crossley, Trafalgar Square—Giving alarm in cases of fire
1303 C. B. Reitz, Leadenhall Street—Water meters.—A com.

4th May, 1867.

1304 Herbert Allman, Ampthill Square—Bearings of axles
1305 Robert Russell, Derby—Prevention of down-draught in fireplaces
1306 Justin Thèvenet, Belgium—Slide valves
1307 Léon Delperdange, Belgium—Telegraphic wires
1308 J. H. Johnson, Lincoln's Inn Fields—Magneto-electric signal lights.—A com.
1309 Evan Leigh, Manchester—Construction of landing stages
1310 John Hemsley, Melbourne—Manufacture of double tubular fabrics
1311 T. W. Bunning, Newcastle-upon-Tyne, and William Cochrane, Northumberland—Getting coal and stone
1312 H. A. Bonneville, Bayswater—Weeding apparatus.—A com.
1313 N. M. Shafer, New York, U. S.—Binders for papers
1314 Lieut.-Col. J. Baker, Army and Navy Club—Generating electricity for motive power
1315 Peter, Brash, Leith, and William Young, Straiton—Lamps
1316 T. R. Crampton, Great George Street—Preparing clay

6th May, 1867.

1317 William Bradbury, Prestwich—Stillages for baling presses
1318 B. H. Smith, Astwood Bank—Papering needles
1319 P. Haenlein, J. Fisher, and R. G. Fisher, Great George Street—Telegraph posts
1320 Jean Nadal, Newman Street—Portable fountain
1321 James Ball, Sheffield—Bricklayers' trowels
1322 K. J. Winslow, Belvidere—Propulsion of carriages
1323 Richard Taylor and Ebenezer Poulson, Shadwell—Securing the sheets of sails
1324 William Clark, Chancery Lane—Looms for weaving.—A com.
1325 William Schofield, Oldham, and Edmund Smith, Rochdale—Self-acting damper
1326 W. R. Lake, Chancery Lane—Locks.—A com.
1327 George Wilson, Sheffield—Manufacture of steel tyres
1328 George Wilson, Sheffield—Buffers
1329 Thomas Crow, West Ham—Burning hydro-carbon oils
1330 J. H. Johnson, Lincoln's Inn Fields—Lighting gas lamps.—A com.

7th May, 1867.

1331 S. E. Hallett, Bedford Place—Capturing fish
1332 S. E. Hallett, Bedford Place—Trawl nets
1333 S. E. Hallett, Bedford Place—Capturing salmon
1334 J. S. Cavell, Gray's Inn Square—Construction of toys
1335 Eugène Bourdon, Paris—Valves
1336 George Harthan, Congleton—Communicating motion
1337 John Booth, Oldham—Lubricators
1338 Robert Marsden, Horwich, and Urias Bromley, Ardwick—Railway break
1339 W. W. Greener, Birmingham—Fire-arms
1340 A. H. Gilman, Massachusetts, U. S.—Spinning
1341 Edmond Faucher, Nantes—Forming wooden hoops
1342 J. B. Blythe, London Street—Ornamenting metallic surfaces.—A com
1343 Robert Smith, Strichen—Collars for horses
1344 Charles Burrell, Thetford—Dressing seeds
1345 W. E. Newton, Chancery Lane—Explosive compounds.—A com.
1346 W. R. Lake, Chancery Lane—Cleaning grain.—A com.
1347 George Krauss, Munich—Tenders for locomotives
1348 N. W. Wheeler, Brooklyn, U. S.—Hydraulic valve gear
1349 N. W. Wheeler, Brooklyn, U. S.—Skylights
1350 N. W. Wheeler, Brooklyn, U. S.—Packing of slide valves
1351 N. W. Wheeler, Brooklyn, U. S.—Controlling the introduction of fluids to surface condensers of steam engines
1352 James Crockatt, Dundee—Securing the handles of doors
1353 H. J. Saxby, Woolwich—Locks

8th May, 1867.

1354 James Fairley and Alfred Fairley, Birmingham—Plantation hoes
1355 Charles Layton, Liverpool—Producing parts of steam fittings
1356 C. D. Abel, Chancery Lane—Combustible gases.—A com.
1357 James Gaskell, Blackburn—Building cops
1358 W. R. Lake, Chancery Lane—Fastening for bands for baling cotton.—A com.
1359 Joseph Nixon and Jabez Winterbottom, Sheffield—Drilling tangs
1360 T. A. Weston, Birmingham—Ratchet levers
1361 T. J. Mayall, Bouverie Street—Printing
1362 H. R. Cottam, St. Pancras Iron Works—Bedsteads
1363 G. E. Donisthorpe, Leeds—Combing wool
1364 H. R. Cottam, St. Pancras Iron Works—Ornamental balusters
1365 Rowland Wood and Austin Wood, Islington—Pressing paper

9th May, 1867.

1366 S. W. Worssam, Chelsea—Working wood
1367 Albert Fournier, La Rochelle—Manufacture of toy boats from paper
1368 G. H. Cail, Pembroke Square—Preventing the explosion of steam boilers
1369 T. A. Weston, Birmingham—Springs for buffers
1370 George Sims, Queen Elizabeth Street—Reversible waistcoats
1371 John Bowden, Preston—Water-closet tap
1372 Matthew Fleming, Dundee—Washing bottles
1373 T. A. Weston, Birmingham—Friction coupling breaks
1374 Thomas Brown, Newgate Street—Egg beater.—A com.
1375 Thomas Brown, Newgate Street—Coffee pot.—A com.
1376 Auguste Herce, Paris—Pianos
1377 W. E. Newton, Chancery Lane—Welding iron and steel.—A com.
1378 W. E. Newton, Chancery Lane—Lubricating the stuffing boxes of steam engines.—A com.
1379 Ratcliffe Andrew, Derby—Communication between passengers in railway carriages and the guard
1380 Charles Ritchie, Brixton—Casks
1381 George Jeffries, Orford Hill—Closing cartridges

10*th May*, 1867.

1382 George M'Kenzie, Glasgow—Illuminating gas
1383 F. B. Dœring, Duke Street—Rotary engines.—A com.
1384 W. Bracewell, W. Pickup, and B. Lund, Burnley—Valves for steam
1385 Ralph Mellard, Rugeley—Preparing and mixing food for animals
1386 John Norman and William Hay, Glasgow—Manufacture of flour
1387 Allan Cooper, Birmingham—Box pickers for looms
1388 Charles Jones, Liverpool—Coal mining machinery
1389 James Johnson, Pendleton, and Alfred Giles, Manchester—Drying yarns
1390 C. H. Trask, Jeffreys Square—Steam engines.—A com.
1391 John Combe, Starbeck—Winding cops
1392 William Smyth, Camberwell—Navigating the air
1393 William Clark, Chancery Lane—Brick-making machines.—A com.

11*th May*, 1867.

1394 Charles Marlow, Salford—Cases for clocks
1395 J. A. Knight and Charles Bastand, Hanway Street—Feed bag for horses
1396 James Reilly, Hulme—Swimming, floating, and diving
1397 John Walker, Sheffield—Standards for weighing apparatus
1398 G. F. Russell, Piccadilly—Rotary engines
1399 George Browning, Cheapside—Buttonhole sewing machines
1400 John Piddington, Gracechurch Street—Boring gun barrels.—A com.
1401 John Steven, Glasgow—Gauges for steam boilers
1402 Thomas Nelson, Edinburgh—Manufacture of cards and tablets
1403 William Clark, Chancery Lane—Bleaching textile materials.—A com.
1404 John Watkins, Balsall Heath—Axles for carriages
1405 J. W. Dalby and Pickles Constantine, Bradford—Improved yarns
1406 W. R. Lake, Chancery Lane—Caster for tables.—A com.
1407 W. R. Lake, Chancery Lane—Metal cocks.—A com.

13*th May*, 1867.

1408 G. A. Neumeïjer, Döbitz—Gunpowder for mining purposes
1409 J. G. N. Alleyne, Alfreton—Puddling furnaces
1410 R. H. Padbury, Shoreditch—Shuttle for sewing machines
1411 George Lunge, South Shields—Preparation of ores
1412 H. A. Bonneville, Bayswater—Washing powder.—A com.
1413 James Leetch, Birmingham—Cartridge holders
1414 Charles Eastwood, Ravensthorpe—Looms for weaving
1415 W. Cormack, Commercial Road—Effecting the revivification of animal charcoal
1416 W. E. de Bourrau, Bordeaux—Evaporators for concentrating saccharine fluids
1417 J. W. Butler, Dunmow—Armour-plated ships
1418 M. D. Rogers and J. Wilson, London—Fire-escape
1419 Edward Field, Chandos Chambers—Generating steam
1420 John Clark, Orchard Street—Railway breaks
1421 William Sodo, George Street—Refining liquors

14*th May*, 1867.

1422 A. H. Colles, Manchester—Signalling between passengers, guards, and engine drivers upon railways
1423 Charles Randolph, Glasgow—Propelling vessels
1424 Benjamin Barrett and Henry Mackenzie, Birmingham—Egg boilers
1425 J. J. Bastin and L. A. Baum, Paris—Perpetual movement
1426 J. G. Jennings, Lambeth—Water-closets
1427 A. M. Clark, Chancery Lane—Raising liquids.—A com.
1428 Edmund Walker, London Street—Windlasses
1429 A. V. Newton, Chancery Lane—Axle-boxes and bearings.—A com.

15*th May*, 1867.

1430 J. C. Ellison, Shelf—Removing card boards from the folds of fabrics
1431 C. Brazil, Chorley, and R. Grime, Preston—Wetting and drying wefts or yarns
1432 H. C. Baildon, Edinburgh—Nature printing from plants
1433 Ernest Smith, Glasgow—Obtaining violet colouring matters
1434 Francis Bonney, Kensington—Ships and boats
1435 Charles Perry, Bradford—Flattening hackle pins or comb teeth
1436 W. Clark, Gateshead, and E. Walker, Poplar—Raising or moving heavy weights
1437 W. D. Tate, Islington—Stopping bottles
1438 Job Johnson, Brooklyn, U. S.—Submarine tongs for gathering oysters
1439 George Nimmo, Jersey, U. S.—Metal wheels for railroad cars
1440 A. V. Newton, Chancery Lane—Billiard tables.—A com.
1441 G. Coles, Gresham Street, J. A. Jaques and J. A. Fanshawe, Tottenham—Wheeled carriages
1442 G. Coles, Gresham Street, J. A. Jaques and J. A. Fanshawe, Tottenham—Permanent way of railways
1443 Edmund Edwards, Buckingham Street—Treating mineral substances

16*th May*, 1867.

1444 John Harper, Clerkenwell—Single cylinder printing machines
1445 P. A. de Berenger, Maida Hill—Kilns for burning limestone
1446 Charles Robert, Liége—Fire-arms
1447 J. M. Napier, Lambeth—Printing machinery
1448 G. T. Bousfield, Brixton—Manufacturing illuminating gases.—A com.
1449 J. H. Johnson, Lincoln's Inn Fields—Fire-arms.—A com.
1450 G. F. Harrington, Ryde—Marine baths
1451 C. E. Brooman, Fleet Street—Sewing machines.—A com.
1452 James Griffiths, Wickham Market—Apparatus for sowing seeds
1453 John Sadler, Birmingham—Nail-cutting machine
1454 J. M. Stanley, Chancery Lane—Increasing combustion in furnaces

17*th May*, 1867.

1455 Julien Denis, Blackfriars—Treating fibrous substances
1456 F. P. Warren, Cosham—Tobacco pipes
1457 Henry Peel, Ovenden—Looms for weaving
1458 P. M. Parsons, Blackheath—Manufacture of artificial granite.—A com.
1459 Augustine Angot, Paris—Spring petticoat
1460 Henry Hollingsworth, Strood—Shoe for piles
1461 A. L. Dowie, Glasgow—Treating iron
1462 John Smith, Little Moorfields—Driving sewing machines
1463 W. R. Lake, Chancery Lane—Water gauges.—A com.
1464 W. R. Lake, Chancery Lane—Manufacture of white lead.—A com.
1465 W. R. Lake, Chancery Lane—Producing chloride of lead.—A com.
1466 George Bernhardt, Radcliffe—Doubling frames and machines for spinning fibrous materials
1467 Simon Regan, Leeds—Boilers and furnaces
1468 Edward Webb, Worcester—Looms for weaving
1469 A. V. Newton, Chancery Lane—Lowering and picking up ships' boats.—A com.
1470 C. E. Brooman, Fleet Street—Calculating apparatus.—A com.
1471 J. L. Clark, Westminster Chambers—Communicating between the passengers, guards, and engine drivers

18*th May*, 1867.

1472 T. Richardson, Newcastle-on-Tyne—Extracting oils from vegetable substances
1473 James Sloan, Liverpool—Ships' water closets
1474 J. T. Bland and E. J. Bland, Broadway, and T. Brevetor, Ash Grove—Bland's improved ball cock
1475 C. P. Button, Cheapside—Surgical bands.—A com.
1476 Bernardo Sheil, Brompton—Paving for roads and ways
1477 A. H. Brandon, Paris—Washing wool.—A com.
1478 H. A. Dufrené, Paris—Transferring heat.—A com.
1479 C. W. Dixon, Wickham Market—Slide valves
1480 J. Smith and J. L. Ibbotson, Barrow-in-Furness—Raising and lowering revolving shutters
1481 John White, Cheapside—Binder for sewing machines
1482 E. O. Hallett and W. T. Hallett, Weymouth—Book-rest
1483 George Haynes, Ellesmere—Brushing boots and shoes
1484 W. E. Gedge, Strand—Cartridge for le faucheux guns.—A com.
1485 J. L. Norton, Belle Sauvage Yard—Drying malt
1486 J. L. Norton, Belle Sauvage Yard—Washing and drying wool

20*th May*, 1867.

1487 Thomas Metcalf, Newton Heath—Burning all hydro-carbon oils
1488 John Bottomley, Laister Dyke—Looms for weaving
1489 Thomas M'Comas, Old Broad Street—Raising sunken vessels.—A com.
1490 H. A. Dufrené, Paris—Beer engines.—A com.
1491 A. M. Clark, Chancery Lane—Instrument for sharpening cutlery.—A com.
1492 C. D. Abel, Chancery Lane—Apparatus for filling sacks.—A com.
1493 E. H. C. Monckton, Threadneedle Street—Preserving meat
1494 Humphrey Chamberlain, Wakefield—Steam boiler furnaces
1495 J. G. Tongue, Chancery Lane—Furnaces for steam boilers.—A com.
1496 Edward Bond, Whitby—Buildings ships' sail-yards
1497 V. Barford, Market Hill, and J. Skerman, Eynesbury—Boilers for steaming roots
1498 Edward Young, Oughtibridge—Treating iron ores
1499 W. M. Cranston, Upper Thames Street—Reaping and mowing machines.—A com.
1500 David Thomson, Old Street—Steam rollers

21*st May*, 1867.

1501 John Owens, Salford—Manufacture of pile
1502 John Davies, Smethwick—Machinery for folding sheets of paper
1503 E. H. C. Monckton, Threadneedle Street—Steam ferrying vessel
1504 John Gough, Kerby Street—Arming presses
1505 Marc Runkel, Regent Street Quadrant—Indicator for carriages
1506 George Hurdman, Wolverhampton—Charcoal box-irons
1507 W. Nichols, J. Burnley, T. Wilson, and G. Jackson, Leeds—Machinery for cutting flax and hemp
1508 Samuel Holt and Greenwood Holt, Bacup—Pickers
1509 C. H. Shurnham, Kilburn—Self-acting and ink-supplying writing pen
1510 S. H. Foster and Thomas Bunney, Leicester—Manufacture of looped fabrics
1511 W. F. Henson, New Cavendish Street—Rails for railways
1512 J. Stenhouse, Rodney Street, and J. Duncan, West Ham—Treatment of animal charcoal
1513 Andrew Barclay, Kilmarnock—Injecting and ejecting liquids and fluids
1514 A. V. Newton, Chancery Lane—Central fire metallic cartridge.—A com.
1515 O. Wasserman, and J. H. Herbst, Call—Refining the pig-lead scraped by means of reguline zinc.
1516 John Mabson, Newcastle-upon-Tyne—Sewing machines

22*nd May*, 1867.

1517 Daniel Adamson, Newton Moor Iron Works—Furnaces
1518 James Collins and James Smethurst, Bolton-le-Moors—Dressing hides
1519 J. Cartland, Birmingham, and H. Bold, Longton—Ornamenting bowls of castors for furniture
1520 J. Hargreaves, Appleton-within-Widnes, and T. Robinson, Widnes—Manufacture of steel and soft iron from cast iron
1521 W. J. Murphy, Cork—Fire-arms
1522 R. S. Moss, Manchester—Wearing apparel
1523 William Brookes, Chancery Lane—Lubricator.—A com.
1524 A. M. Clark, Chancery Lane—Fabric for the manufacture of machine belting.—A com.
1525 J. M. Kaufmann, Glasgow—Apparatus for travelling through the atmosphere
1526 W. E. Newton, Chancery Lane—Portable photographic apparatus.—A com.
1527 Antoine Martin, Nantes—Preserving grain
1528 A. A. Hely, Manbey Grove, and John Marshall, Greenwich—Obtaining pressure
1529 E. W. Hughes, Queen's Square, and T. H. Head, Dowgate Hill—Rotatory engine and pumps

23*rd May*, 1867.

1530 F. H. Johnson, Grafton Street—Gas blow pipes
1531 M. Theiler, sen., R. Theiler, and M. Theiler, jun., Barnsbury Road—Telegraphic instruments
1532 C. W. Siemens, Great George Street—Conveying telegraphic dispatches through tubes
1533 O. Feuiller, Paris—Table with double face
1534 A. M. Clark, Chancery Lane—Typographic printing machines.—A com.
1535 Edward Howell and Thomas Hardy, Poole—Root-cutting machine
1536 Simon Atkinson and Thomas Atkinson, Otley—Folding paper
1537 C. E. Brooman, Fleet Street—Kilns.—A com.
1538 T. G. Green, Church Gresley Pottery—Manufacture of articles of earthenware

1539 A. V. Newton, Chancery Lane—Feed water for the tenders of locomotive engines —A com.
1540 Louis Stuckenschmidt, Seething Lane—Apparatus for landing grain from ships

24th May, 1867.

1541 Henry Blackham, Wolverhampton—Spectacle frames
1542 J. M. Muterse, Guérande—Extinguishing fires
1543 Clement Martin, Hammersmith, and James Griut, Battersea—Railway buffers
1544 T. W. Helliwell, Brighouse—Looms for weaving
1545 G. M. Wells, Aldermanbury—Boots and shoes
1546 Louisa Slatter, Drayton—Cases for transporting butter
1547 A. M. Clark, Chancery Lane—Steam generators.—A com.
1548 George Howard, Berners Street—Parquet flooring
1549 Charles Sanderson, Worksop—Melting cast steel
1550 Thomas Greenwood, Leeds—Boring metals
1551 G. T. Bousfield, Brixton—Braiders for sewing machines.—A com
1552 J. M. Napier, Lambeth—Appliances for serving mustard

25th May, 1867.

1553 James Simpson, Hulme—Producing photographic pictures
1554 Allen Oldroyd, Clapton—Tobacco pouches
1555 A. M. Clark, Chancery Lane—Watered fabrics.—A com.
1556 I. Baggs, High Holborn, and F. Braby, Deptford—Treating calcareous salts
1557 William Ryland, Birmingham—Tea pots and coffee pots
1558 William Dutton, Winsford—Furnaces
1559 W. P. Struvé, Cwm Avon—Furnaces

27th May, 1867.

1560 H. B. Barlow, Manchester—Coupling pipes.—A com.
1561 Herbert Frost, sen., and Herbert Frost, jun., Manchester—Measuring fluids
1562 W. P. Metchin, Parliament Street—Taking copies of lithographs
1563 William Affleck, Swindon—Improved tyre
1564 R. R. Knott, Fulham Road, and John Jeyes, Stanley Road—Preparing wood
1565 P. A. J. Dujardin, Paris—Electric telegraphs
1566 William Snell, Clement's Inn—Mining and stone dressing machines.—A com.
1567 W. H. Whettem, Portsmouth, and Edmund Walker, Poplar—Screw propellers
1568 J. C. Mewburn, Fleet Street—Harvesting machines.—A com.

28th May, 1867.

1569 Henry Pether, Clapham Road—Ornamental bricks
1570 M. Loam, Hampton, and F. H. Fearns, Walworth Common—Microscopes
1571 E. T. Hughes, Chancery Lane—Combined seeder, cultivator, and roller.—A com.
1572 G. H. J. Simmons, Stanhope Street—Lamps
1573 F. J. Vandenvinne, Brussels—Plough for clearing uncultivated land
1574 William Coulson, Shamrock House—Door-frames of furnaces
1575 H. A. Bonneville, Bayswater—Production of motive power.—A com.
1576 H. A. Bonneville, Bayswater—Carding wool.—A com.
1577 H. A. Bonneville, Bayswater—Weaving wool.—A com.
1578 Henry Cockey and F. C. Cockey, Frome—Seal or dip pipes
1579 T. F. Cashin, Sheffield—Compound lever
1580 William Mitchell, Northwold—Food for sheep
1581 L. H. Dethiou and F. Beaubry, Paris—Tongueless buckle
1582 A. M. Clark, Chancery Lane—Washing and bleaching cloths.—A com.

29th May, 1867.

1583 David Tunks, Accrington—Galvanometers
1584 Richard Pollit, Bolton-le-Moors—Steam boilers
1585 W. J Burgess, Brentwood—Fingers for mowing machines
1586 J. F. N. B. Simons, Frankfort-on-the-Maine—Steam boilers
1587 Carlo Minasi, College Place—Musical wind instruments
1588 Thomas Mitchell, Stacksteads—Felt carpeting
1589 F. J. Brean, Bristol—Producing letters in gold on glass
1590 J. R. Cooper, Birmingham—Cartridges for fire-arms
1591 J. M. French, Birmingham—Measuring spirits
1592 Robert Newton, Lower Providence Mill—Steam boilers
1593 F. B. Gage, St. Johnsbury, U. S.—Harmonizing the lights and shades in photographic impressions
1594 T. E. Passee, Russell Square—Obtaining motive power
1595 W. B. Ritchie, Belfast, and J. G. Willans, St. Stephen's Crescent—Drying peat
1596 Henry Turner, Thames Iron Works—Marine steam engines
1597 Edward Jones, Pontblyddyn—Safety lamps
1598 A. V. Newton, Chancery Lane—Producing mosaic veneers
1599 W. E. Newton, Chancery Lane—Producing printing blocks for printing various fabrics.—A com.
1600 Thomas Greenwood, Leeds—Milling machines
1601 Henry Oakes, Birmingham—Manufacture of earrings

30th May, 1867.

1602 Hugh Bain, Alexandria—Dyeing yarns
1603 C. E. Brooman, Fleet Street—Photographic albums.—A com.
1604 James Francombe, Newport—Engine for obtaining motive power
1605 William Orr, Greenock—Treating sugar
1606 James Astbury, Birmingham—Casting Bessemer metal steel
1607 William Wood, Monkhill—Printed tapestry carpets
1608 W. E. Newton, Chancery Lane—Treating fabrics.—A com.
1609 W. E. Newton, Chancery Lane—Manufacture of felted fabrics.—A com.
1610 Tony Petitjean, Brydges Street—Procuring the more perfect combustion in the burning of fuel
1611 M. A. F. Mennons, Southampton Buildings—Magneto-electric batteries.—A com.
1612 W. R. Lake, Chancery Lane—Fire-arms.—A com.

31st May, 1867.

1613 F. J. Demanet, Ixelles—Giving draught to chimneys
1614 John Scott, Oxford Street—Subduing and extinguishing fires
1615 Benjamin Shakespeare and William Shakespeare, Wollaston—Furnaces
1616 James Hinks and Joseph Hinks, Birmingham—Lamps
1617 F. W. Dolman, Jermyn Street—Obtaining essential oil.—A com.
1618 J. Le Butt, Bury St. Edmunds—Hay-making machines
1619 Thomas Porter, Sunderland—Apparatus for supporting music books
1620 James Earl of Caithness, Hill Street—Ships' compasses
1621 Rees Reece, Landilo—Producing cold
1622 James Lancelott, Birmingham—Manufacture of ornamental chains
1623 Phineas Lawrence, Basinghall Street—Applying adhesive agents to pieces of paper
1624 A. M. Clark, Chancery Lane—Regulating motive power.—A com.

1st June, 1867,

1625 Thomas Poultney, Baltimore, U. S.—Revolving fire-arms
1626 Thomas Poultney, Baltimore, U. S.—Fire-arms
1627 Wilmot Bradford, London—Combining wood for the construction of boats
1628 A. G. Schaeffer, Newcastle-on-Tyne—Obtaining increased light in the combustion of illuminating matters
1629 F. B. Houghton, West Reading—Steam boilers
1630 Andrew Albright, Dryden, U. S.—Covering buckles
1631 Enoch Tayler, Acorn Court—Composition or arranging of type

3rd June, 1867.

1632 Theophilus Horrex, South Square—Machines for hatching eggs
1633 William Pidding, Beresford Street—Reels or receivers
1634 Edward M'Lean, Stoke Newington—Pianofortes and harmoniums
1635 W. H. Richardson, Glasgow—Manufacture of iron and steel
1636 J. F. Brown, Glasgow—Looms for weaving
1637 C. L. J. Carville, Paris—Construction of boilers
1638 David Barker, Northfleet—Chambers for drying artificial fuel
1639 Samuel Harwood, Northfleet—Construction of walls and buildings
1640 R. W. Page, Park Walk—Hand garden engines and hydropults

4th June, 1867.

1641 J. Inshaw, Birmingham—Electrical clocks
1642 M. Cavanagh, Kensington—Lock spindles
1643 J. Waddington and B. Longbottom, Barrow-in-Furness—Casting metals
1644 G. Davies, Serle Street—Paddle wheels.—A com.
1645 T. Laidlaw, Sillerbit Hall—Manufacture of yarns
1646 E. Meldrum, Bathgate—Purification of paraffin
1647 J. H. Johnson, Lincoln's Inn Fields—Racks for whips.—A com.
1648 J. M'Owen, Rochdale—Fire grates
1649 H. W. Hart, Clapham Common—Construction of rafts.—A com.

5th June, 1867.

1650 D. Hanson, Dukinfield—Furnaces
1651 J. Gaudet, Gresham Street—Fog signal
1652 N. Rausch and E. L. Darlet, Brussels—Artificial fuel
1653 T. H. Saunders, Coombe Road—Gas stove
1654 C. Boulay, Paris—Galvanic batteries
1655 G. White, Queen Street—Carbonates of soda.—A com.
1656 L. B. Schmolle, Aldermanbury—Crinoline skirts
1657 J. Evans, Birmingham—Spring hooks
1658 J. M Milbank, Greenfield Hill—Fire-arms

6th June, 1867.

1659 J. Adams, St. John's Terrace—Railway tickets
1660 B. Templar, Holly Bank—Window sashes
1661 E. Bland, Bury—Steam engines
1662 J. Livesey, Victoria Chambers—Paper-folding machines
1663 T. Brown, Newgate Street—Artificial limbs
1664 T. Wilson, Birmingham—Fire-arms
1665 R. Maynard, Whittlesford—Chaff-cutting
1666 E. Ellis, Nottingham—Twist lace
1667 G. R. Turner and W. J. Allen, Upper Thames Street—Gates and fences

7th June, 1867.

1668 T. Sturgeon, Manchester—Lamps
1669 C. E. Giojola, J. H. Gray, and P. Martmengo, Birmingham—Inkstands
1670 A Elvins, Queen's Road—Fire-arms
1671 A. L. Bricknell, Stratford-on-Avon—Rotary pumps
1672 J. Offord, Well Street—Signalling on railway trains
1673 H. Cowe, Manchester—Warming apparatus
1674 E. S. Atkinson, Hill Top—Treatment of oakum
1675 D. Rorison, Glasgow—Reeds for looms
1676 J. Petrzwalski, John Street—Photo-megascope
1677 E. T. Hughes, Chancery Lane—Sewing machines.—A com.
1678 W. W. Wood and J. Wood, Sheffield—Fitting boiler tubes
1679 J. Sheldon, New Haven—Brushes.—A com.
1680 A. Barry, Bromley Grove—Cranes
1681 J. Offord, Wells Street—Wheel carriages
1682 W. Tribe, Horndean—Velocipedes
1683 R. Scott, J. Nixon, and J. Beaumont, Dumfries—Woollen cloths
1684 J. Warburton, Hythe—Registering gas.—A com.

8th June, 1867.

1685 J. Horton, Birmingham—Flyers
1686 H. Parker, Robinson's Terrace—Tobacco pipes
1687 J. Glisenti, Brescia—Gun barrels
1688 J. Collier, R. Howarth, and W. Cryer, Bolton-le-Moors—Knitting healds
1689 J. C. Ralston, Newry—Making candles
1690 H. Willis and G. Rice, Worcester—Sewing machines
1691 J. Hargreaves, Appleton—Motive power
1692 J. Turner and R. B. Dunnett, Liverpool—Stamping machine
1693 O. Barrett and H. Leggot, Bradford—Knife cleaner
1694 N. Thompson, Abbey Gardens—Connecting pipes
1695 A. Parkes, Birmingham—Ornamenting paper
1696 R. E. Pepys, Poultry—Securing straps
1697 H. Rolle, Boston—Propellers

10th June, 1867.

1698 J. Crompton, Bolton—Revivifying malt liquor
1699 W. French, Keppel Mews North—Roughing horses
1700 J. Macintosh, North Bank—Moulding plastic materials
1701 T. Robinson, Widnes, and J. Pierce, Warrington—Zinc
1702 A. L. Dowie and R. M'Intyre, Glasgow—Punching and embossing
1703 J. H. Kerly, Percival Street—Fastenings for brooches
1704 F. B. Doering, Duke Street—Cutting coal
1705 J. Conolly, Ramsgate—Motive power apparatus
1706 T. Holt, Trieste—Steam boilers
1707 W. Orr, Greenock—Separating moisture from substances, revivifying charcoal, and treating sugar
1708 R. Logan, Glasgow—Securing windows, blinds, shades, doors, and shutters

11th June, 1867.

1709 R. Hornsby, J. Bonnall, and H. Shields, Spittlegate Iron Works—Thrashing machines.—A com.
1710 H. A. Bonneville, Porchester Terrace—Vessels for fecal matters
1711 C. Toft, Handsworth—Cruet frames
1712 J. Graham, Banford—Bleaching vegetable fibres
1713 H. Fletcher, Old Hall Street—Artificial fuel
1714 J. H. Johnson, Glasgow—Rolling metal.—A com.
1715 G. P. Hill, Wood Street—Boxes and drawers
1716 J. Thom, Hull—Expressing oils
1717 S. W. Wood, Cornwall—Elevating, weighing, and moving grain
1718 J. Fletcher, Bow—Charcoal retorts
1719 W. Rowan, Belfast—Cleaning flax
1720 J. C. Fuller, Bow—Telegraphic insulators

12th June, 1867.

1721 J. Millward, Birmingham—Steps for vehicles.—A com.
1722 J. F. Boetius, and J. Eichhorn, Delahay Street—Manufacture of types
1723 J. Cochrane, Grange—Pontoon bridge
1724 C. D. Abel, Southampton Buildings—Horse shoes
1725 D. & D. Crichton, W. Donbavand—Looms for weaving
1726 F. D. Frost, London Street—Spinning fibrous material
1727 J. H. Snelson, Ashby-de-la-Zouch—Axles and boxes
1728 A. M. Clark, Chancery Lane—White lead

PARIS EXHIBITION.

FRENCH CIVIL ENGINEERING.

PORT OF MARSEILLES.

We purpose, in the present and subsequent papers, to give some general notices of a few of the more prominent or interesting objects of civil engineering proper, *i.e.*, of structural engineering as contradistinguished from machinery, &c., exhibited at Paris; doing so rather in a form to be a useful guide to the professional visitor, than as treating exhaustively of any one of the very many subjects coming under this great head.

France, as regards civil engineering, shows herself unquestionably in the very front rank of all the nations who appear in the Champ de Mars. Indeed, the far larger proportion of whatever is shown in the way of civil engineering is hers. England exhibits almost nothing, unless we except Mr. Chalmers' big sectional diagrams of his projected tunnel beneath the English Channel. The German states, including Austria, show a few models and designs, as do also Italy and Spain; but France shows proudly, and in every direction, without and within the building. To this result several causes have concurred, but the chief and most notable one of a positive character and which has influenced the great display made by France, is the existence of the *Administration des Ponts et Chaussées*. To the final *fiat* and approval of this great national office of public works, every work in France, public or private, that affects more than close and immediate private interests, must be submitted prior to any permission to execute becoming legal. The result is that every work in France of the slightest importance is known to this body, and its officers can put their hands upon plans and documents of all such instantly. Besides this, models executed with all the accuracy, skill, and beauty for which France has long been celebrated, are produced of every work of a monumental character, or which possesses claims to originality or ingenuity, and are deposited in the museums of the *Ecole Centrale*, or of the *Conservatoire des Arts et Métiers*, or of the *Ecole des Mines*, &c.; and thus a solid repertory, as it were, of all the great works in France, up to almost the date of the last finished, exists, which can be drawn upon, and the very best of the best produced at a day's notice. This is just what has been done by the French executive in illustrating the present state of French engineering. France, however, has not been content with so much. She has exhibited in the fullness of reality some of her greatest works, which were of a character to admit of it—such, for example, as the iron lighthouse destined for New Caledonia, which occupies the park—and has, besides the models, produced designs and maps of many remarkable works or projects for works, and in a few cases, as in that of the Suez Canal, has illustrated these by every accessory and elaboration that can give interest and completeness to them in the eyes of observers, whether popular or professional.

One of the best effects of the existence as a real executive power, of the *Ponts et Chaussées* in France is, that beyond question, fewer failures in large works occur through ill-considered designs or insufficient methods of construction or erection, and fewer hideous enormities than are daily perpetrated amongst us in Great Britain by English engineers (who, whatever may be their soundness of judgment as mere constructors, or the eminence of their position, are yet men devoid of all taste or genuine mental culture), are to be found executed in France. Such a design as that for the monstrous iron *whales*, in the shape of the hog-backed box girders that straddle askew across the approach to the London Bridge Railway Terminus, for example, and are a disgrace to London and to England, in point of style, would have been "burked" in its infancy, or rather would never have been produced at all in France. So, also, such a disaster as the fall of the Lendal Bridge at York, a few years back, while in progress of erection by the contractors, is very little likely to occur in France: for all the methods to be employed in the execution of every large work are thought and calculated out beforehand by competent men, who have to satisfy other competent officers of the *Ponts et Chaussées* that these are sufficient before they are adopted. Still, bureaucracy is not infallible in France more than elsewhere. Serious mistakes in projects have been made, notwithstanding every preliminary provision for consideration and check, and even failures in execution. Both have been exemplified in the case of the water-works for the supply of Marseilles. The water of the river Durance was known to be milky and turbid, more or less, always; but it was assumed that the separation of this turbidity was a question of subsidence. Part of the project, and a highly important one as respected its pecuniary return, was based upon the obtaining a supply so abundant that the water could be used not only for the supply of the city, but for scouring out the ancient *Joliette*—the old, foul, and pestilential tideless rocky inlet that formed the harbour—and for a copious diversion for irrigation by the way, as the waters ran towards Marseilles. The works were completed as designed, and it was then found that a residue of the suspended mud in the waters was so impalpably fine that sixty days' rest in a settling basin was insufficient to let it all deposit, and domestic filters have been largely introduced in Marseilles to render the water wholesomely potable. But the vegetable world refused to drink it at all. It was tried for irrigation, but the crops watered by it died—the *stommata* of the fine root fibres got rapidly choked by the impalpable fine mud that left the water always opalescent, and so the plants died asphyxied, so to say; and we believe we are correct in saying that the use of the water for irrigation has had to be abandoned. After much discussion in print, some of it of rather an angry character, it was determined to construct some greatly larger settling reservoirs at or near the head waters than had ever been contemplated. The Realtort Reservoir was put in hand, but ill fortune seemed still to pursue those water-works, for within the last three months the reservoir when partly filled showed decisive symptoms of the same sort of dislocation of its embankment that has brought more than one of our British reservoirs to grief; and a serious disaster was only just prevented by the promptitude and energy with which the reservoir was emptied. These incidents are not intended to disparage either the truly magnificent works by which Marseilles is supplied with its immense volume of water, nor the engineers of those works, nor French engineers in general, but merely to point to the fact, that while some authorized and *real* public supervision over all great works is of high value, and desirable in every country—our own included—yet that no such supervision can infallibly prevent occasional mistakes, or even disasters, where the great forces of nature, or new and unknown conditions have to be dealt with: all that can be done is to reduce these *contretemps* and contingencies to a minimum, and that we believe is done by the existence of the *Administration des Ponts et Chaussées* in France.

Amongst the magnificent collection of models and maps, or designs, exhibited by this department of the French Ministry of Agriculture, Commerce, and Public Works, are those of the improvements, we might rather say of the creation of the port of Marseilles, and of the machines, tools, and methods by which these vast works have been constructed. The Marseilles of ancient days, as founded by Pythæas and Euthymenes, was nestled at the upper end of a natural re-entering little bay, or cavity, in the iron-bound rocky limestone shore of the Mediterranean; and with but little artificial work in aid, this constituted the harbour of that which is now the Liverpool of the South of France, up to the days of Louis XIV. That monarch made Marseilles a military port; but towards the end of the eighteenth century Toulon became the great naval arsenal of France in the Mediterranean, and the arsenal and military basin of Marseilles were abandoned and given up to commerce. This little port of the old Joliette, on both its sides, sufficed for the mercantile needs of the place up to 1792, when a time of great local prosperity showed that more than 5000 vessels annually entered and left the port. Then came the wars of the First Empire, and the mercantile depression they produced; and it was not until after the Empire and its great founder had been finally swept away at Waterloo, nor for five years of recovery afterwards, before the first great improvements of the port in 1820 were inaugurated. Great improvements had been effected before 1844, by which time its annual naval entries amounted to more than 18,000 ships, and the tonnage to more than 2,000,000 tons per annum. The existing basins having no more than 29 hectares of water surface, and about 2700 metres lineal of quayage, could not longer accommodate this great commerce. The city had become rich. In 1844 legislative power was given to construct the new Joliette of 22 hectares area, united with the old by a canal or channel since formed into dry docks. This was constructed at a cost of 15,000,000 of francs, the chief work being the great exterior or sea-face breakwater and quay of 1100 metres long, and in water of an average of 12 metres in depth.

In 1855 all this proved inadequate to increasing trade necessities; and under the present emperor's government the comprehensive project was devised and completely organized, of which a large part has since been completed, fully enough for all immediate wants, but the

characteristic of which is that it admits of future indefinite extension. The general idea of these grand harbour works is that of a succession of moles rooted in the natural rock of the shore and shooting out seaward to considerable distances, and nearly parallel with each other. Outside these, and nearly at right angles with them, runs a great sea breakwater, which, while it produces smooth water between all these moles, and converts the spaces between into so many great basins, leaves a space free for communication inside between them all. The moles, as well as the breakwater, are constructed partly of large parallelopipedal blocks of concrete or *beton*, each of 10 cubic metres volume, which form the exterior, and of natural irregular blocks of limestone obtained from quarries at the islet of Frioul, about 5 kilometres by sea from the port. The sea slope of the breakwater is formed of these great blocks thrown in promiscuously; the land side, as also both sides of the moles, are mainly built up vertically of these blocks laid in the water, which is from 12 to 22 metres in depth, without any mortar. The hearting is composed of the limestone, the larger natural blocks being so disposed as to include in *their* interior the small stuff and *debris* of the quarries, so that nothing of the labour of the quarry work shall be lost. The quarries at Frioul are worked upon the same plan as those at Holyhead, and if we mistake not, were worked by "headings" and mines, long before mining was there employed. As much as *twenty-six tons* of gunpowder, in six headings, and producing 100,000 cubic metres of stone, have been fired at once at Frioul, being more than four times as much as has ever been fired at once at Holyhead. The headings are fired by electricity. The produce of the quarries is sorted into four classes of blocks as to size; the small stuff, of from 2 to 100 kilogrammes, being the least, and blocks of 4000 kilogrammes, or about 4 tons and upwards, the largest class. The stuff is brought by tramways and locomotives, by excellently devised wagons, &c., and put into barges of various constructions, which are towed to the place for deposit and dropped. The great squared concrete blocks are shipped and laid in place by well-devised floating derricks wherever it is not practically better to lay them from the work already executed. These blocks are composed of five parts by volume of pebbles and fragments of limestone rock, and three parts of mortar. A cubic metre of the mortar consists of sharp sand with 350 kilogrammes in weight of slacked hydraulic lime, equivalent to 204 kilogrammes of lime to the cubic metre of the concrete block. The lime is highly hydraulic and got at Theil, and the concrete blocks thus made have been proved perfectly to resist the chemical action of the magnesian salts of the sea water, while the weight of the blocks has been proved sufficient to resist the heaviest seas that roll in towards the port in the heaviest gales.

In the moles have been laid (of the last great basin, Bassin Napoleon) at the usual rate of progress per month, 20,000 cubic metres of natural stone blocks, &c., in hearting, and about 3750 cubic metres of concrete facing blocks; and the cost per metre forward of the moles of the Napoleon Basin has been 9000f. for 30 metres wide in 17 metres depth of water. At the present moment Marseilles possesses basins covering 90 hectares of water surface, and with 9000 metres running of wharfage. Close to the latter are vast ranges of warehouses or stores, capable of containing 130,000 tons of merchandise, admirably arranged and fitted up with hydraulic lifts and lowering apparatus; and the entire of these vast stores are penetrated by railways, and in immediate proximity to the main merchandise lines of the south of France railway system, placing the port in direct locomotive communication with all France and all Europe.

When all the project shall have been completed, the port will possess nearly 150 hectares of basin, and 14 kilometres of quay, and the whole of these will have close alongside a minimum of 12 metres and a maximum of 22 metres of water, so that the *Great Eastern* herself might take in or discharge cargo direct from or upon one of these grand quays. The works of the port have been executed under the supreme direction of M. Toussaint, ingénieur en chef des Ponts et Chaussées; the acting engineer being M. Pascalis (who is also engineer to the municipality, and therefore of the water-supply works); the contractors for the works of the New Joliette being MM. Dussaud, Barthelou, Rabattu, Mouries, and Blanc; the works of the Bassin Napoleon being executed under M. Pascalis as engineer in chief, with M. André as acting engineer, and MM. Dussaud Brothers, the contractors.

Contemporaneously with the execution of these noble works at the harbour, vast demolitions and the construction of many kilometres of new and broad streets have been going on in the city itself. The old, narrow, gloomy, picturesque, but morally and physically deadly, streets of the ancient city—those out of which the terrible Marseilloise pikemen of the Revolution issued and were marshalled for their march to Paris—after having been carefully photographed in every point, by special order of the emperor, have been to a great extent razed, and in their place lines of houses and shops of palatial grandeur have arisen. A splendid exchange, with noble palaces for the residences of the prefect and mayor, have been finished. The wealth of the city, even with all this prodigious outlay, has increased and is increasing; and with the liberality and grandeur of appreciation that almost always characterizes great and prosperous seats of trade and commerce, the citizens have founded and built noble edifices for their municipal pictures and libraries, and their institutions of the liberal arts and for education, and finally have built a magnificent palace upon a promontory overlooking the harbour and port for the emperor; and not forgetful of the science upon which, above all others, navigation depends, astronomy, have founded a fine observatory, and endowed it with probably the grandest achromatic telescope at present in existence, one the construction of which has been directed by Le Verrier, and upon the mechanical details of the mounting of which the illustrious Foucault has lavished his great resources.

So far as the harbour and port are concerned, what we have described is illustrated in the Paris Exhibition by several noble models to a scale of 0·04 metres, by a superb map in relief of the site of Marseilles and the mouth and delta of the Rhone, by a geometrical plan of the city and port, and by a perspective view of the completed project, seen as if from a balloon from some ten miles away over the sea. This view is one of the most exquisite pieces of architectural and engineering landscape painting that we have ever seen. Indeed this and all the other engineering and mechanical drawings which are exhibited in the Champ de Mars possess an excellence of clear execution and perfection of detail, with beauty of colouring, to compare with which we have nothing equal in England, not even in the best architectural drawings exhibited annually at the architectural exhibition or the Royal Academy of London. And while South Kensington is lauding itself and being lauded for the wonderful impress it has made in the way of improvement in the application of the fine arts to manufactures, &c., it would be well for us all to take note and consider how it is that there are no engineering or architectural or mechanical draughtsmen in Great Britain who can make a finished or even a common skeleton working drawing to compare in merit with those produced daily and by hundreds by Frenchmen and Germans.

Cherbourg is another port of France, some of the great works at which are also well exhibited at the present Exhibition, more particularly the mode of constructing the foundations of Fort Chavagnac there, an isolated work, very much like our forts at Spithead now in course of construction. These works, the latest in progress at Cherbourg, are being carried out under the direction of M. Pasquier Vauvilliers, by the same contractors as for parts of the port of Marseilles, viz., MM. Dussaud and Rabattu. We must postpone to another occasion, however, any more detailed description of them. They, like many other of the civil engineering exhibits of France, demand a place for themselves.—Ed.

THE PARIS EXHIBITION.

ROBINSON'S VISIT TO THE CREUSOT WORKS.

In that part of the Champ de Mars which lies between the great Exhibition edifice and the Seine, the visitor will perceive a building bearing the simple inscription "Creusot." If the practical man calls to mind that this is the name of the place where Messrs. Schneider & Co. have their great ironworks and manufactory of machinery, he will probably be tempted to enter the structure just to see what they can do in this way in France; and if he be of the old-fashioned John Bull turn of mind he is more likely to be surprised than delighted, when he perceives to what a pitch of excellence the French have arrived in a department which is supposed to be peculiarly English, as it certainly was originally. Before we particularize what we ourselves found in the building, it may be well to state that the town of Creusot is situate at the distance of about 248 miles from Paris to the south-east, and that the population has increased from 8000 in 1851 to 24,000 in 1867. It lies in the

immediate neighbourhood of a coal basin, yielding the Company 250,000 tons a year, of which a large relief model is to be seen here, as well as another model still larger of part of the town itself, and the vast workshops where 6500 hands are employed. The total number of persons in their mines, at the works, on their railway, &c., amounts to 9950. Their annual production of iron reaches 130,000 tons.

The first thing to attract attention is an imposing mass of ironwork, which, on approaching, proves to be the engines of 950 nominal, 3800 real horse-power, intended for the cuirassed steamer, the *Ocean*. They are constructed on a plan which has been adopted by the imperial navy for their large vessels of war. They have three horizontal cylinders of 6 feet 10½ inches diameter. After duly admiring this fine specimen of mechanical skill, we turn to an engine of 265 nominal horse-power, one of a pair of engines with which the coast-guard ram *Cerbère* will be fitted. They are double-piston horizontal engines; the coupled cylinders have a diameter of 4 feet 3 inches, and are surrounded by a jacket of steam. Condensation is effected by injection. Elsewhere in the Exhibition may be seen an express locomotive and tender, made for our own Great Eastern Railway! Has it come to this, that our railway companies can obtain either better or cheaper engines in France than in England? Either way, the fact deserves the serious consideration of every well-wisher of our country, especially when we remember that, in the machinery department of the Exhibition building, there is a locomotive made at Esslingen, in Wirtemberg, for the East Indian Railway Company, part of a large order, as already mentioned in our pages. The express locomotive before us bears the Creusot number of 1079. Pursuing our walk we next meet with a pair of powerful horizontal engines to be applied to a mine pump; a locomotive and its tender intended for a good's train, the type of sixteen engines now at Creusot; a pretty little locomotive intended for the mines of Blanzy, where five like it are already at work (the wheels are so contrived that the engine can be employed on railways of different width); lastly, a powerful drilling machine. The workmanship of these machines need not be surpassed. Amongst other specimens of Creusot work is a rolled plate, weighing 1690 lbs., and measuring in length 44 feet 4 inches; in width, 3 feet 5½ inches; and half an inch in thickness; and there is a collection of rolled, joists, angle irons, and cylindrical bars 41 feet 5 inches long; bars tied cold in knots; and boiler plates flanged and worked without a weld in various ways, to show the ductility and strength of the metal. In cases protected by glass are specimens of the coal and coke used at the works, the ores which supply them with metal, and different qualities of cast iron, beginning with that of ordinary quality, and advancing to that which is priced at 200 francs per ton above the ordinary make. Then there are bars and rails bent or broken to show their fibre, &c.; and specimens of the forms which hot or cold iron can be made to take under the hammer without welding, which to the uninitiated must seem quite wonderful. Upon the walls are hung not only drawings of machinery, but plans and drawings of the works, public buildings, and artisans' houses at Creusot. We were much interested by the evidence which is given here of the attention paid by the Company to the education of the children of their work people. Schools were founded in 1857, and at the present time there are upwards of 2200 pupils attending them. Here we see an account of the whole system of management, the course of study, specimens of drawings and writing by the pupils, of needlework by the girls, &c. A catalogue of the contents of the workmen's library is exhibited. We believe that the Company's efforts in this direction have been attended with highly satisfactory results, both as regards the public generally, and their own interests in particular.

ON SOME POINTS OF PRACTICE IN IRON FOUNDING.

No. XVIII.—(*Continued*).

SEEING the value of rapidly cooling, it has been often proposed to make chills hollow (in their walls), or to surround them with such an exterior wall, of plate iron, for example, as should produce a space for a cold water jacket, and so enable the chill to be kept cooler by the circulation of a current of cold water therein during the process of casting and cooling. With cast-iron chills the attempt would be perilous, if carried out to such an extent as to be of any real value. We conceive, however, that it might prove not only practicable, but advantageous and economical, to form hollow water-jacket chills of *wrought* iron, though we believe that this has not only never been done, but, so far as we know, not previously even proposed. Chill moulds for elongated projectiles for rifled artillery might thus be made with considerable economy, and their lightness would be such as to save a good deal in the labour of handling. Chill moulds also of a far greater size, such as for casting iron-mill rolls, might be formed of wrought-iron plate about 1½ inch thick, welded into a cylinder, and a concentric thinner plate, and end rivetted on to form a water jacket, containing a large volume of water, capable of being rapidly changed during the pouring.

No *interior* chill piece *slipped into* an *outer shell*, forming a water jacket, would be of the slightest use. The conductivity of the same metallic mass is interrupted to an extent that would never be anticipated, by even merely cutting it through, and yet still applying the two surfaces in the closest contact that tool work, such as planing, grinding, or scraping, can produce. Six pieces of plate glass laid together, each of ¼ inch thick, though they will lift each other up by the perfection of their opposed plane surfaces, yet conduct heat applied by excess of temperature to one side, much worse than a solid piece of the same glass of the same total thickness, viz., 1½ inch. What is true here of glass, whose molecular structure is vitreous (or colloid, in Dr. Graham's nomenclature), is still better developed where the solids, having the opposed surfaces, are crystalline, as in cast iron and other metals.

Hollow water chills, however, would not be free from some difficulties in management, more especially in withdrawing the castings. Were copper procurable as cheap as cast iron there can be no doubt but that it would make a vastly better material for a chill mould, if lined with cast or wrought iron, or other still more infusible material, than either of these metals; for its conductivity is to that of cast iron as about 800 to 360, while the specific heats are not widely different, or as 950 to 1100, in round numbers.

In the construction of cast-iron chills the interior surfaces are frequently finished (for the rougher sort of work, such as ore crusher rolls) rough from the loam, but for the finer sorts of work the interior has to be bored out. The surface thus from the cutting tool is usually rusted thoroughly, by wetting for several days with urine or with dilute hydrochloric acid; the rust rubbed off, and the surface is then prepared in different ways by different chill casters. The most usual method is to blacklead the interior surface, the plumbago being laid on and polished by a brush, as it is done upon a stove grate. Coating with "blackwash" of coal dust, or of coal dust and molasses diluted with water, we have also known employed, and smoking with a pitch torch. In reality no preparation of the sort is absolutely necessary, though it may perhaps be advantageous in giving a rather finer face to the casting, after the first casting has been made in the mould. As soon as the interior surfaces have got well oxidized by heat and air, all danger of soldering, unless by very bad management, is ended, and preparation by coating not indispensable. No coating of "clay wash," even ever so thin, ought ever to be employed, as seriously interfering with the heat-carrying properties of the chill. The grand requisites really necessary to procure fine smooth chilled castings are: that the metal shall be brought into the chill in one or more "gaits" or streams of *massive volume*, so that the mould shall fill fast, and that portions scattered, on first striking the relatively cold sides of the chill mould, shall not become so cooled that they form cold sets, or loose imbedded bits of flinty chilled iron in the rest of the casting. Should such pieces stick in the outer surfaces, as they are apt to do, the casting is probably lost, and worth nothing. For the same reason the temperature of the liquid iron for chill casting should always be high at the moment of pouring, and this not only because that the proper quality of iron for good chilling flows thick and "liverey" at all times, but because of the prodigious rate at which the liquid metal is so robbed of its heat at the moment of entering the mould, that unless it have some surplus over its temperature of liquefaction in reserve, the skin of the casting is sure to be full of unsightly "cold shots" and deformities.

The gaits must be so arranged, too, that the jets of entering liquid do not continue to squirt or strike against the interior walls of the chill for any length of time at one place. Should they do so, the interior face of the chill here becomes rapidly porous, open, and finally eaten into a cavity, and after a few castings made in the same chill, this excavation becomes such that loam is needed to smooth it over, to the detriment of the uniformity and beauty of the casting.

This sort of change happens, in the course of time and use, to more or less of the whole interior surfaces of all cast-iron chills. The surface

gets soft, porous, and sometimes here and there cavernous, through the erosive action exercised at each filling with the molten metal. If the chill be such that it can be bored out afresh, for example, and a new surface then obtained, which is practicable where the dimensions of the casting are not rigidly determinate, an old chill may be kept very long usable. But cases occur in which dimension is a prime element, and there the chill becomes useless as soon as thus roughened inside. This is pre-eminently the case with the moulds for casting chilled projectiles, or those of white cast iron, and along with the nearly insuperable difficulty of casting any two such projectiles of *precisely* the same diameter in iron moulds, forms the most serious disadvantages of the so-called "system" of such casting which now goes under Major Pallisser's name. By that "system" it is impossible that anything can be saved in the cost of casting over casting by machine moulding in dry sand moulds, made in properly prepared flasks the shape of the projectile, and by which the diameters of all like projectiles might be kept precisely alike without difficulty, the shot being still of white cast iron, and just as hard and tough and smooth as if cast in iron moulds.

No change of *chemical* constitution takes place even after years of frequent use that the writer of these papers has ever been able to discover by careful analyses, in the cast iron of chills by the continued action of the molten iron, unless it be absolutely "skin deep" upon the interior surface. But the *molecular* constitution of such moulds does change considerably, and in very old chills the cast iron is frequently found crystallized in distinctly formed and largely developed crystals, in forms that plainly point to the cubic system. Their distribution in the whole mass is not uniform, and the localities in which the development appears greatest on splitting up such a chill, appears to defy explanation on any established principles.

The metal of which chills are to be made *may* be of any quality; and in some foundries the most refuse stuff that can be collected is deemed good enough to make them of; while in others, the cheapest "keeshy" Scotch pig is employed because it is low in price.

But to make a good and *durable* chill, the pig iron selected for casting it should not be very far different in quality from that of which the chilled castings to be made in it ought to be formed, as already described. It should be hardish, bright gray mottled iron, almost as hard as it can be conveniently turned or bored. In fact, the iron that will serve to cast a first-rate steam cylinder for a large class of engine, will make also a good chill, and a durable one. The cast iron of a chill will be better in proportion as it is denser, and more close grained; and if the experiments of Johnson and Calvert (Phil. Trans., 1858) are to be fully accepted as conclusions, the difference of conductivity between the coarse, dark, crystalline Scottish iron, and close, dense, bright mottled, or nearly white pig iron, may be of considerable importance in the working of the chill, for bar iron, steel, and cast iron were found by these experimenters to have conductivities respectively as the numbers 436 : 397 : 359. In this, as in many other respects, much remains to be accurately ascertained as to the physical properties of iron in its various states. Nothing is known *precisely* as to its conductivity in any of these states.

Chills are very commonly in large foundries, when out of use, employed "for weighting boxes"—*i.e.*, keeping down "top parts," or are thrown about the foundry yard, exposed without any cover to rain and rust. By this they suffer much, lose accuracy of form, and alter in dimensions, and absorb wages in scraping off rust with old files, &c., when coming again to be employed. Chills out of use should have the interior tallowed, and be stacked under cover, and in a dry place. When to be again used, the tallow should be scraped away, and then *carefully* washed off with soft soap and black ash, with plenty of hot water. A little tallow, or even soap, remaining on the skin, powerfully tends to promote "soldering" between chill and casting.

Chills that are in several pieces, or of irregular forms, require to be jointed with care, and to be so put together that there shall be no mutual constraint between the parts so connected, which are first and those which are last suddenly heated up.

Nothing is more difficult in the iron-moulder's practice than to assign the precise dimensions that should be given to a chill, to turn out a chill casting of as exactly as possible a given size. The problem, in fact, like that of obtaining a casting of a given size from a wood pattern in "greensand" is rigidly impossible; it can only be nearly approximated, and less nearly in proportion to total size, than in the case of the sand moulding; because here we have not only to deal with the contraction of the iron, and with certain conditions which modify its final amount, but we have also to deal with the expansion, and in some cases the unequal expansion, of the metallic mould itself.

Let us take, for instance, the case of a large roller of considerable length, such as a calender roller, to be cast in a chill. It will be found nearly impracticable to cast such a roller truly cylindrical in a chill. The hot metal enters the lower end of the cylindrical chill *first*. It expands that end rapidly, and the chill for the moment becomes conical. Were it free from internal hydrostatic pressure, it would recover its cylindric form; but its lower end, after being expanded by the first and hottest metal, and therefore expanded most (*i.e.*, more than the upper end), is exposed to the pressure of the head of metal up to the moment of consolidation and contraction to such an extent, of the solidified casting, that this pressure is relieved by the retreat of the cooling surface of the casting away from the walls of the chill.

It is thus found that deep cylindrical chills which have been often and long used, get permanently a little enlarged at the lower ends. The chill dare not be *inverted* in use in successive castings, for fear it should thus expand at both ends, leaving a narrow part towards the centre, such as might hinder the withdrawal of the casting. The actual dimension of a casting made in a chill, is that of the cavity of the chill at the moment, when such an amount of consolidation has taken place in the exterior *couches* of the casting within it, that these become competent thenceforth to sustain the residual fluid and pressure of the interior metal of the casting still remaining liquid in the heart of it. Thus the dimensions of the casting are not those of the chill when cold, but of the chill heated and expanded up to a certain point. But that certain point depends upon a number of conditions, some of which are not precisely alike for any two cases or operations. The larger the bulk of the casting, the more the chill will be expanded before the support of its walls ceases to be necessary to the casting within in every case. But the lower the temperature at which the iron is "poured," and the more "quick setting" the "make" of iron employed is, the earlier will this support become unnecessary, and therefore the less the size of the chill be increased by expansion up to this moment, which determines the size of the casting while still hot, but yet externally solid.

The chill, too, will vary in its actual increase of dimension by expansion in some relation to its thickness; for the colder external parts exercise some constraint by grip of the more heated and expanded internal parts, so that other dimensions of the chill, as well as the size of its cavity, are influential in determining the size of the casting that shall be made in it. But up to this point we have merely referred to the chief determinants of the final dimensions of the chill casting while *still hot*, solid externally and partially, and still at a very high temperature. But these are not its dimensions when cold; the casting itself has still to contract as it cools down to atmospheric temperature. The retreats due to this, as we have pointed out, or at least as may be inferred from the principles of molecular aggregation in solidifying cast iron, as stated by us in a former paper, will differ with differences of form in the casting, as well as with differences in its absolute bulk, and that assuming the co-efficient of dilatation of the metal in all cases rigidly the same. If the form of the casting be irregular or complex, the retreat will vary in amount in different directions; and in such case, *minutely* considered, the casting and the chill never can be exactly similar figures even, much less of equal dimensions. But if the form be regular and simple, as a cylinder roll, for example, the final retreat of the metal of the casting will be less than that due to the coefficient of dilatation of the metal of which it is made.

The reason of this is not difficult to see. The exterior cylindrical shell of the first consolidated metal (the chilled part in fact) becomes a sort of rigid arch all round the still liquid and hotter metal within; and whilst at first the resistance of the latter to the grip by contraction of the surrounding consolidated shell tends to stretch this latter, at a subsequent period, when the whole mass has got solid, the contraction of the interior parts tends to drag these away from the exterior arched shell, or, which is the same thing, to compress this together tangentially. The final result is a retreat different in amount from that which would have been due to the coefficient of dilatation of the metal, if acting free from all internal constraints.

It may seem that we have been needlessly refining here, and that this minute philosophy is useless in its application to practice. It is, however, desirable to possess clear thoughts upon the matter before us always; and here we have merely stated enough distinctly to point out

the impracticability of fixing beforehand, or by any other method than by trial and error, the dimensions to be given to the cavity of a chill, to produce a casting of *precisely* a predetermined size.

There are limits of error to this even in sand or loam casting; but the limits are wider, and the uncertainty of variation in these between one casting and another greater, for a given size of casting, in the case of the chill casting than in any other. From the extreme superficial hardness of the chill casting, any surplus dimension becomes proportionately difficult of remedy. These are some of the real and the insuperable objections to the chill casting of projectiles.

From the moment when the outer *couches* or walls of a chill casting have become solidified, and its dimension at that temperature thus fixed, a void space between the casting and the chill begins to arise; for the casting itself, though as yet very slowly, is still cooling and contracting. But the chill, still receiving accessions of heat from the hotter casting within it, is still continuing to expand; and thus the void space due to the retreat inwards of the casting and outwards of its chill continues to increase up to that point, at which, if all were left introduced, the chill would begin to dissipate heat faster than it received it from the still cooling casting within. Before this point is reached, the skillful "chill moulder" always takes measures for the withdrawal of his casting from within the chill. The earlier he can safely do so before, the better. It must, however, rest with his experience and judgment, to decide how early he may venture to hitch a chain round his casting (at the neck of a roller, for example), and to pull it out, without danger of pulling the still rather tender hot mass asunder, or distorting, however slightly, its form by the force applied.

The casting should *never* be permitted to cool down completely in the chill; for besides the risk of its getting "gripped" by the latter, the goodness of the chilling is thus inevitably deteriorated. Complete cooling in the chill is in fact tantamount to a sort of annealing. Whilever the casting and the chill cavity are in actual contact with each other, cooling goes on by conduction into the chill, and by radiation and evection from its exterior; and the transport of heat by the conductivity is rapid and effectual. But the moment the retreat of the chill and casting from each other have produced a space, if of but one-twentieth of an inch wide, between them, filled only with intensely heated air, the further transmission of heat from the casting takes place (except at some accidental or other point of remaining contact) primarily by *radiation only*. The transmission thus is excessively slow in proportion to that by conduction, especially as here, where the radiation is from one hot surface to another very little below it in temperature; and the upshot is, that were the casting, assuming it tolerably large (as for instance the large roller that we have taken all along for an example), to remain in the chill, it would take probably days to get down to atmospheric temperature. During all that time, certainly during a good deal of the earlier part of it, molecular changes would continue to go on in the metal of the casting, tending to undo the work of the chill. It follows, therefore, that the moulder's best practice is to get his chill casting out of the chill at the earliest moment that "it is free" and will bear to be handled safely. The general usage is to bring the withdrawn chill casting into the open air, and leaving it to cool finally upon the ground, giving some attention as to whether its form and position may be such as to risk any distortion of form by the cooling unequally, through contact with the ground, or by draughts or ascending currents of air evecting heat, or by rain, &c. There is rather less danger of this with a chill-made casting of like size and form, than with one made in sand or loam. Some "chill moulders" prefer to cover up thinly with loose greensand their chill castings upon the floor of the foundry, and so let them cool. The effect of this is certainly to give a more beautiful and workmanlike appearance to the skin of the casting, which acquires a fine dark blue black tint. It is a matter of taste, and otherwise not important; but the principle to be held in view is that the sooner a chill casting can be got quite cold, the better will be the chilling. But chilled castings should *never* be cooled by throwing water upon them, still less by plunging them into water. Distortions, or even fractures of the most unexpected sort, may be thus produced; for we must ever bear in mind that the internal molecular constraints are far greater and more enduring in chill castings than in any others of equal bulk and like form. Nor is any advantage whatsoever, in the way of increased superficial hardness, obtained by plunging a chilled casting into cold water, in the same way as we should harden a piece of cast steel. This fact affords a remarkable proof of the curious, and so far unexplained, molecular difference between chilled cast iron and cast steel (equally chill cast in the ingot). Both are almost identical (or may be so) in chemical constitution, and have the closest physical relations in most of their properties; but the one can be hardened in cold water, the other cannot.

The writer of these papers once tried to increase the hardness of surface of some ore-crushing rolls, which had been unluckily chill cast of unfit metal, by heating them to a bright red in a boilermaker's plate furnace, and then *plunging* some into cold water and *rolling* others forwards and backwards in a shallow trough of cold water. There was no perceptible increase of surface hardness in either case, and in the latter a curious exemplification, upon a demonstrative scale, of what no doubt always goes on more or less if a chill casting be cooled by watering the surface, as by a hose pipe and rose, &c. The rollers, after being rolled forth and back in the water for some few minutes, were found to have their chilled cylindrical surfaces split to the depth of perhaps an inch, into numerous prismatic fragments, by tolerably regular but very minute fissures, extending parallel to the axis of the roll and at right angles to these, the distances being about an inch or rather less, the diameter of the rolls being about 30 inches. It was simply that the cooling suddenly of the exterior brittle chilled *couche*, and faster than the interior, had caused the former to contract and so grip the latter as to fissure itself thus. After the whole roller had become perfectly cold, these fissures had so closed up as to have become perfectly invisible; but there they were still, complete breaches of continuity in the material to the depth of about 1½ inch, as was proved upon breaking up the rolls, which for the purpose intended were condemned as useless.

We have thus stated pretty nearly all that is of practical importance to state on the subject of "chill casting." Casting in iron moulds is most commonly adopted, for the purpose of chilling, as an end. But occasionally iron moulds are employed as matter of convenience or of economy in time and wages, instead of those of sand or loam. Thus, railway chairs have been moulded in iron moulds, as well as round shot in Smeaton's days. In these instances the partial chilling, which was reduced to a minimum by blackwashing the iron mould, and by the choice of a metal of bad chilling qualities—*i.e.*, rich in uncombined carbon, &c.—was unimportant. In other cases the chilling of one portion of the casting may be the object in view, leaving the other parts soft. Thus the cams or wipers that lift the "stampheads" used for breaking up refractory ores in large mining operations, as well as those stampheads themselves, are cast with the working faces against chills imbedded into the sand which forms the remainder of the mould. Thus also the patent chilled iron ploughshares of Ransomes & Sims are cast. But cases may occur in which great economy and convenience may arise from making castings in iron moulds, the *whole* of the metal of which, nevertheless, in the end, must for use be as soft and tough as if cast in sand. This is quite practicable; and several years ago the writer of these papers cast thus in iron moulds the hollow naves through which ran the axle of a peculiar sort of patent wrought-iron wheelbarrow for navvies' use. The mass of iron in this hollow nave was small, its total length being about 10 inches and the axle about 1 inch diameter, and the general form of nave being two hollow cones, connected at their bases, where there was a circular projecting rim all round, into which the four flat wrought-iron arms of the wheel were cast. Iron moulds in two halves were prepared, with seats into which those arms were placed; a sand core stood in the centre, and the iron was poured round. When these little naves were thus cast—the metal being chiefly bright gray No. 3 Beaufort pig, with a little hard scrap and Scotch pig, No. 1—they were on fracture perfectly white, hard and chilled all through, being nowhere more than about ⅜ inch thickness. The cores were then cleaned out, and the wrought-iron arms being dipped into thick clay wash and charcoal and let dry, the naves and arms were heaped in a furnace prepared to keep them at a low red heat, without excess of air, for about fifty hours. At the end of that time the cast portion had become converted almost completely into soft cast iron again; in fact, as regarded the thinner portions, so soft and tough as to be really malleable cast iron.

This may afford an illustration of the many uses to which chilling may be applied, in combination with those other varied and precious properties possessed by cast iron under proper treatment, of becoming hard or soft, brittle or tough, almost as we will. Many important improvements yet remain to be effected by the adaptation of chill casting

to purposes to which it has never yet been applied, employing methods to give hardness to the surface only, preserving still the toughness of the interior; for example, to the casting of the teeth thus of spur or other toothed gear.—Ed.

THE ROYAL AGRICULTURAL SOCIETY AT BURY-ST.-EDMUNDS.

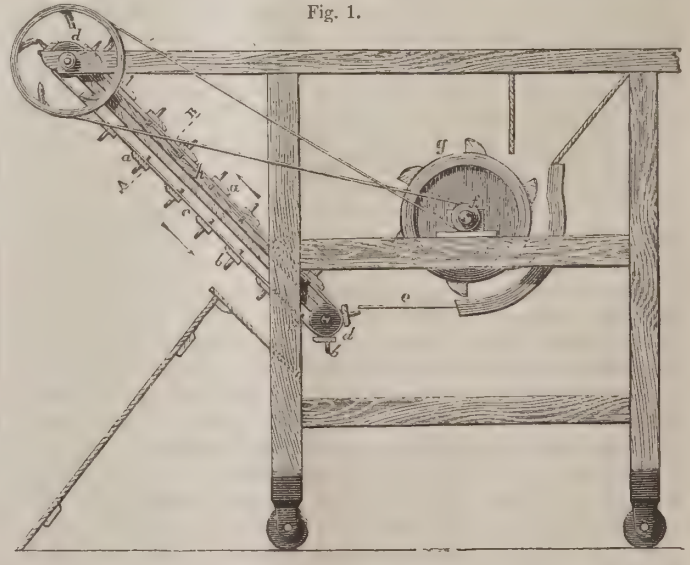
The pretty little town of Bury-St.-Edmunds has this year been the scene of the largest display of agricultural implements which the Royal Agricultural Society has ever brought together. The show "yard," as it is the fashion to call the large grass field in which the stock and implements are usually displayed, is situate on a slight eminence about half a mile from the centre of the town; and as its surface comprises both level and sloping ground, it is admirably adapted for bringing out the capabilities of the numerous traction engines which vie with each other in speed and manageability; but of these we shall speak presently. The "yard" comprises about 40 acres, and contains nearly 4 miles of sheds. There are no less than 282 stands for implements alone, and 251 exhibitors, and, according to the catalogue, 4804 different articles exhibited; but, we may observe, this underrates the true number, as we found many articles not entered in the official list. From these few statistical notes our readers will be enabled to form some idea of the vastness of the display, and will readily admit that a complete notice of everything even of merit, would occupy more space than our pages will afford. Commencing with stand No. 1, and following nearly in the order of the catalogue, our attention was first attracted by Comstock's rotary spader, exhibited by J. T. B. Porter & Co., of Lincoln. This is intended as a substitute for the plough—a number of rotary forks being made to turn over the soil by the travelling action of the implement, which is of exceedingly light draught.

Walter A. Wood, of Upper Thames Street, exhibits a fine collection of his well-known grass-mowing and reaping machines, to which he has added several recent improvements, comprising an improved lever action for raising the cutter bar, double-speed gearing for reaping purposes, spring seat, &c. John Baker, of Wisbeach, exhibits his patent elastic reaping-machine rakes, applied to one of Samuelson's self-raking reaping machines. A first-rate show of ten excellent machines is, we need hardly say, made by Samuelson & Co., of Banbury. A large display of miscellaneous articles is made by John G. Rollins, of Old Swan Lane, comprising some well-constructed pumps for deep well and garden use, as well as for ship's purposes; also an ingenious and simple weighing machine for family use, the invention of Mr. Shaler, of the United States. In this machine the pan is supported on a helical spring; the depression of which brings into play a rack and pinion movement, which turns an indicator or pointer in front of a divided dial. This machine will weigh, with sufficient practical accuracy, from 1 ounce to 25 lbs. Francis Morton & Co. (Limited) have some good specimens of strained wire fencing and monumental park gates, for which this firm has long been justly celebrated. Burgess & Key make a fine display of reapers and mowers. The reapers are the invention of M'Cormick, but have been considerably improved by the makers. Their No. 1 patent side delivery sheaf reaper, adapted also for mowing clover, is an exceedingly well-designed machine, and deservedly obtained the gold medal at the Paris Exhibition. The rake gear, rake and reel, in this machine were supported on one side only, and the whole weight is thereby brought on the large travelling wheel. The crank, moreover, is brought down level with the knife, which is in the same vertical plane as the axle and the wheels opposite.

In a most interesting trial of mowers at Newcastle-on-Tyne, the Burgess & Key machine came off victorious against twenty other competing machines, comprising those of our best makers. Tangye Brothers exhibit the now famous differential pulley blocks in all sizes, and some well-made hydraulic lifting jacks and pumps, amongst numerous other useful articles which would occupy too much space to enumerate. Some ingenious chain corn-drills by Mr. H. C. Besley, of Halberton, were exhibited by Hawkes & Spencer. Munn's self-cleaning horse hoe with disc cutters is exhibited by N. Varty, of Royston. The cutting edges of the hoe when at work were constantly being changed and cleared of any accumulation of weeds. This is undoubtedly a very useful instrument. Mr. Wyatt's adjustable corn screen is exhibited at the stand of the agents, Messrs. Coleman & Marton, of Chelmsford. This implement has already been noticed in our pages. Some good oil-cake cutters for steam and hand power, and a useful-looking three-furrow steam plough invented by the exhibitors, are also to be met with at this stand. One of the most interesting novelties is to be found at the stand of J. & F. Hamand, of Bedford; we allude to Hamand's patent safety steam boiler and superheater. This boiler is built up of a series of vertical wrought-iron tubes, the bursting pressure of which is 2000 lbs. on the square inch. The steam pipes and connections are tested to 500 pounds. Within each vertical tube there is fitted an internal tube for facilitating the circulation, and the whole is connected and held together by horizontal tubes, or water and steam connections at the lower and upper ends respectively of the vertical tubes. Its appearance gives the notion of costliness, but if one-half the advantages which are claimed for it are attained, it may, as the inventors assert, be found after all to be the cheapest as well as the best. This firm exhibits also steam-cultivating machinery for working on a new system. A pair of fourteen-horse self-propelling engines, each fitted with two winding drums, draw two cultivators simultaneously between them to and fro. They have a fine display of steam ploughs also, and several new implements in the form of hand ploughs, harrows, haymakers, reapers, and grass-mowers. William Crankill & Sons, of Beverley, are well represented by some well-made farm wagons and carts. We now approach the stand of John Fowler & Co., Leeds. The display of steam machinery and appliances for steam cultivation is highly to be recommended. The work is good and the machinery is well adapted for the purpose, but as our readers are by this time well acquainted with Fowler's steam-cultivating machinery, we need not say more here. Bayliss, Jones, & Bayliss, make a first-rate display with their continuous flat bar fencing and hurdles, which have been previously illustrated in our pages.

The best show of ploughs is by Howard and by Ransomes & Sims. The latter firm, indeed, appear to exhibit something of everything appertaining to agriculture. Their display of portable steam-engines (about nine in number) gives an aggregate of nearly 100 horse-power. The stand of Messrs. Woods & Cocksedge, of Stowmarket, is, we believe, the largest of any; no doubt their proximity to Bury-St.-Edmund's has much to do with that fact; but, if their display is extensive, it is none the less meritorious. Some of the best appliances to be found at the show for stock feeding will be met with here. They are well represented in the heavier class of machinery by several well-made vertical steam-engines, from seven to eight horse-power. Page & Co. exhibit their well-known brick and tile machine, provided with oil lubricators for

Fig. 1.

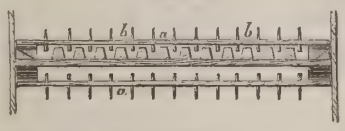


sleeking the corners of the clay as it passes through the die, and thereby preserving them sharper and more perfect. We noticed at the stand of Hunt & Pickering some highly ornamental garden vases, including the "Leicester" flower vase, mounted by Mr. William Goulding. Although they are perhaps a little out of place here, we cannot avoid directing the attention of our readers to these beautiful specimens. Richard Hornsby & Sons, of Grantham, exhibit several new implements, comprising corn-dressing machines, adjustable screens; the "Paragon" mower; also, a "Universal Harvester," which embraces the royal prize

back-delivery reaper, with extras for sheaf side delivery, sheaf back delivery, swathe side delivery, and clover cutting; the "Governor" self-raking reaper is also here exhibited. The stable fittings exhibited by Musgrave Brothers, of Belfast, are admirable specimens, and attracted considerable notice.

Amongst the machinery in motion we noticed a well-made ten horse-power direct-acting steam-engine, by Whitmore & Son. William Tasker & Sons, of Andover, here exhibit an eight horse-power single-cylinder portable engine; a new thrashing machine, with their patent chaff-bagging apparatus; and, also, their new straw shaker, or elevator, of which we give illustrations. A number of strips of wood, *a*, having iron pins, *b*, projecting on both sides thereof—these strips being attached to an endless leather strap, *c*, working round pullies, *d*, carried in bearings in the framing of the machine, and receiving their motion from the pulley, *f*. Inside the endless strap is fitted a board, *h*, corrugated or ribbed on its upper surface, in which corrugation the projecting pins inside the strap are made to pass, carrying with them any straw or cavings which may have passed between the strips; whilst the pins on the top surface of the strips pass through slots cut in the board, *e*, fitted immediately in front of the revolving drum.

Fig. 2.



Messrs. Davey, Paxman, & Davey, of Colchester, exhibit a patented arrangement for drying corn, by surrounding the hummeller with a steam jacket, and keeping it hot with steam taken by a flexible tube from the steam boiler. The greatest attraction in this part of the yard was Blake's stone crusher, exhibited by Mr. Marsden, of Leeds. A new implement, or rather combination of implement and prime mover, was exhibited by Daniel Crowe, of Lynn. It consists of a combined locomotive thrashing and dressing machine. The engine and boiler are inclosed in the frame of the thrashing machine. The boiler is tubular, with return flue, and lies underneath the thrashing mechanism. By a suitable arrangement of framing and clutches, the hind wheels can be rotated, and the whole machine rendered self-propelling.

Oldham and Bootle, of Kingston-upon Hull, exhibit a well-arranged six horse-power bone mill, self-contained, upon a metal bedplate, and provided with revolving screens for separating the crushed bones into ½ inch, ¼ inch, and dust. Professor Thomson's whirlpool pump is exhibited by Williamson Brothers, of Kendal; it works well, and is adapted for raising 1500 gallons per minute. Whilst on the subject of centrifugal pumps, we may also notice the pump exhibited by Owens & Co., Whitefriars. It is the invention of Joseph Bernays, and possesses the advantage of relieving the fan from pressure on its outer surface. A neat little model turbine, equal to one-half horse power, was exhibited by E. R. & F. Turner, of Ipswich. The diameter of this model is about 6 inches, and it was working with a fall of from 5 to 6 feet of water. We noticed some of Schiele's turbines and fans in another part of the ground, but not at work. Ruston, Proctor, & Co. make a good display of portable engines and thrashing machinery; but for excellence of work and design we must certainly award the palm to the fixed and portable engines by Clayton, Shuttleworth, & Co. The display of engines by Tuxford was both large and good. The American heated air-engine, by S. R. Roper, of Boston, was exhibited at work by Riches & Watts. As we have not yet been furnished with data, we cannot speak of its capabilities or consumption of fuel: the specimen at work was said to be equal to two horse-power. It occupied space enough for a twenty horse-power *steam* engine; but compactness is not a feature in hot-air engines. Henry Kinsey, of Nottingham, exhibits a neat horizontal ten horse-power engine. We noticed a well made and designed seven horse-power outside single-cylinder portable engine at the stand of Nalder & Nalder, of Wantage. This engine embraces many points of novelty which are well worthy of notice: amongst these we may mention an improved safety valve, with knife-edged fulcrum and blade-spring beam; also an improved governor fixed on the crank shaft itself, and requiring no driving strap or cog wheels. The joints in the valve and pump-rods are replaced by flexible steel blades, which allow of sufficient play or vibration without the expense of pin joints. There are, in fact, more features of novelty about this little engine than any other in the yard. The general collection of Ransomes & Sims, amongst the working machinery, was one of the largest and best there, comprising several portable and fixed engines and thrashing and dressing machines, with all the most recent improvements.

Amongst the numerous traction engines perambulating the ground in various directions, and performing the most daring manœuvres, we noticed particularly one of ten horse-power by Aveling & Porter, drawing a second engine and trucks; the steering is here accomplished by a guide-knife edged wheel in front, and the power is applied by a pitch chain direct to the driving wheels. Garrett & Sons have an eight horse-power traction, provided with Aveling & Porter's steering contrivance and pitch chain driving motion. E. & R. Turner exhibit a neat-looking traction engine of five horse-power. Burrell has an eight horse traction engine, driven by a pitch chain, and steered by a locking fore axle, governed by a chain and handwheel. Fouller exhibits an eight horse traction and thrashing engine, driven by spur gearing, and steered by a single broad swivel wheel in front. Underhill has a peculiar looking six horse-power traction engine, provided with zig-zag rimmed driving wheels, the object of which is to dispense with the use of grappling irons, but they by no means improve the appearance of the engine. It is actuated by spur gearing, and the fore axle is locked for the purpose of steering by a side rod attached to the axle, and worked by a pinion gearing into a rack on the rear end of the steering rod. Although the largest display of the society, it is, we fear, by no means a profitable one for the exhibitors, who complain on all sides of the scarcity of orders: no doubt the unpropitious state of the weather has had something to do with this, but, on the other hand, it is evident that transactions are differently conducted now; all large makers have their own agents, who are well known, and consequently orders are given at all times, and not as formerly, chiefly at the periodical shows, which were the principal means of bringing the customer and the manufacturer face to face.

As a correct official prize list was not published at the time of going to press, we have deemed it advisable to withhold all mention of the prizes awarded.

COIN AND COINING.

(*Continued from page* 105.)

THE bars produced from each crucible are distinctively arranged and marked with a number to indicate the crucible from which they were poured, and the entire set with a letter to particularize the day on which the melting took place. When these arrangements for identification are complete, assay pieces are cut from the ends of the bars and forwarded in envelopes, correspondingly numbered and lettered, for the examination of the mint assayers. The bars themselves are deposited in the stronghold of the melting house until their quality is reported upon. Occasionally it happens that some of the bars are better or worse than standard. In such cases, which, however, are extremely rare, the defaulting bars are condemned and have to be re-cast. Allowing that the assayer reports favourably of a set of gold bars, they are sent up to the central office for re-weighment preparatory to their being put into work.

It may be stated here that the mode of casting bars for bronze moneys is closely analogous to that pursued in regard to gold; the only differences are that (bronze being considerably harder and requiring less lamination) the bars of the inferior metal are cast very much thinner, and that the assays are not so rigorously exact.* Silver melting is conducted on a somewhat different plan to those pursued in respect of gold and bronze. It may not be improper, therefore, prior to leaving the melting house, to describe wherein the variations consist. It has already been stated that silver intended for conversion into coin is purchased by the master of the mint, and this rule holds good in every case except that of the re-coinage of worn money,† which latter is transmitted from the Bank of England. The silver ingot, as bought in the

* Bronze, as used in the British coinage, is composed of ninety-five parts copper, three parts tin, and two parts of zinc nearly, and this admixture forms a very hard compound.

† Unfortunately, almost all coins deteriorate more rapidly in these days of railway travelling and of multiplied commercial and trading activity, than in the slow and steady times of our progenitors, and many thousands of shillings and sixpences are annually melted down at the mint.

bullion market, is of giant size as compared with the ingot of gold, as witness the following dimensions and weight of each:—

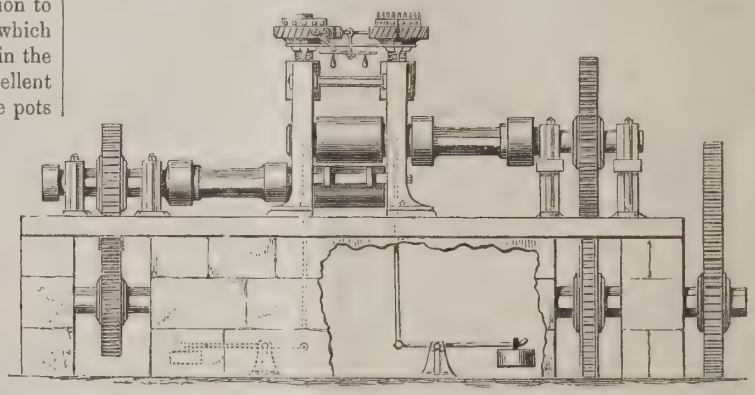
	Length. Inches.	Width. Inches.	Thickness. Inches.	Weight. Ozs.
Silver ingot,	13	5	4	1000
Gold ingot,	8	3	1	200

Their values differ in the other direction, however, the gold ingot being worth £800 and that of silver £250 only. Silver ingots are melted, three together, in wrought-iron pots, moulded under the Nasmyth hammer, and made of the best material. There are eight air furnaces for the reception of the pots, which latter have rims on their upper surfaces to allow of their being gripped by the crane hooks, and lips for the discharge of the fluid metal. The furnace in each case is circular and has a depth of 31 inches, its diameter is 21½ inches. The bars upon which the pot rests—we take one furnace only for facility of explanation—are removable at will, and the furnace, when in action, is partially filled with coke dust; that is to say, the space surrounding the pot is charged with this substance, its uses being to retain any metal which may exude through minute fissures in the pot, and to furnish a non-conducting medium for the latter to be bedded upon. A muffle or ring of wrought iron stands on the rim of the pot, and is covered by a lid. The muffle prevents metal from falling over the top of the pot during the process of fusion, and which might happen when scrap metal, or, in mint parlance, *scissel*,* is being dealt with. The mechanical appliances are more numerous in the silver melting house, as may be imagined, and they are more powerful than those in the gold department. There are mould frames and moulds of similar construction to those mentioned, but there are also swing cranes, the ranges of which extend over the whole of the furnaces, and which are employed in the deposition and removal of the loaded melting pots. An excellent apparatus, known as a cradle, is also used for the reception of the pots prior to filling the moulds. The cradle is so contrived as to form an iron seat for the red-hot pot, and into this the pot is gently lowered by means of the crane. By the agency of a crank-handle, a few wheels, and a quadrant rack, with a pinion, the pot is placed completely under the control of the pourer. The moulds rest on a carriage below. When all is ready for filling the moulds, the operator turns the handle and thus tilts the pot until a portion of the brilliant fluid flows from its lip into the recess, which will shape it into a bar. When one bar has been cast, the next vacant mould is advanced to the proper spot for catching the rich deposit and filled; thus with the next and next, until the pot is empty and many bars are cast. Other ingots are placed in the pot, and it is then returned to the furnace, and so the work of transforming ingots into bars proceeds. In the course of ten hours, in seasons of great pressure, not less than three tons weight of bars are turned out at the mint melting house. The bars when released from the moulds are plunged into cold water baths, and then numbered and lettered as in the case of gold. Assay pieces, too, are detached for the purpose of relegation to the laboratory of the chemist.† Careful weighings being made, and calculations instituted as to the loss of alloy by melting, the bars are now placed under the double locks of the melter to await the judgment of the assayer as to their characters and qualifications. In order to make the description of the melting arrangements complete, the following table of the dimensions, &c., of bars for the production of every kind of silver coin in the British series is annexed:—

Denomination.	Length. Inches.	Breadth. Inches.	Thickness. Inch.	Average Weight. Ozs.
Crown,	22	$2\frac{7}{10}$	1	300
Half-crown,	22	$2\frac{1}{12}$	1	240
Florin,	21	$2\frac{1}{12}$	1	220
Shilling,	21	$1\frac{4}{10}$	1	150
Sixpence,	21	$1\frac{1}{12}$	1	120
Threepence,	21	$\frac{8}{10}$	1	96
Maundy Fourpence,	21	$\frac{8}{10}$	1	96
" Threepence,	21	$\frac{8}{10}$	1	96
" Twopence,	21	$\frac{8}{10}$	1	96
" Pence,	21	$\frac{8}{10}$	1	96

No coinage of crowns, half-crowns, or groats has taken place at the royal mint since 1849, and it appears, therefore, highly probable that in a few years none of those coins will exist except in museums and the cabinets of numismatists.

It is hoped that the reader has been able, and has felt willing to follow us so far in the unravelment of the mysteries of coin and coining, and we shall now ask him to revert to the bars of gold which were left in the stronghold. The assayer has pronounced their composition to be all that the law requires, and they are transferred, *via* trucks and tramway, to the central office Here they are weighed in batches, and their weights recorded in ounces and decimal parts by two officers; one connected with the administrative, and the other with the executive department of the establishment, who sum up totals, and check each other at stated intervals. Finally, the executive officer writes a receipt for perhaps ten thousand ounces of standard gold, and, summoning his men, removes the bars to the great rolling room. Again the bars are weighed with most scrupulous exactness, and this time in presence of the overman of the rolling mills. There are six pairs of rolls in the spacious apartment in question, and they are admirably adapted for their purposes. The frames which support them are of massive cast iron, and span two longitudinal trenches, in which the driving gear is placed. The floor of the room is of granite, and its roof of iron. The whole of the machinery was erected, when the mint was founded, by the celebrated John Rennie; and it is much to his credit to be able to say that now, after more than half a century has elapsed, it would be difficult to improve upon it. The following is an illustration of the largest mill in the mint rolling room, and which is known as the "breaking down" mill.



It is thus called, because all bars, whether of gold, silver, or bronze, are passed through it in the first instance, and thus broken down from their original thickness; the other sets of rolls are mounted in a manner very similar to that seen in the engraving, so that from it an excellent idea will be gained of the whole. The rolls in all cases are of chilled cast iron, and their surfaces are as bright as the helmet of a guardsman on Hyde Park review days. In the breaking down mill, the upper roll is balanced by means of counterpoise weights and levers, placed in the trench below. Two vertical adjusting screws, surmounted by worm wheels, pass through the mill frames, and a spindle carrying two worms connects the wheels. When the crank handle on the worm spindle is turned, it moves both screws upward or downward, as may be required, and thus increases or lessens the distance between the rolls. An index affixed to one of the adjusting screws shows at any moment the exact space which separates the rolls. The couplings on the upper roll are loosely fitted on their shafts so as to allow of the proper amount of play, without risk of breaking its neck. Near to the mill is a pair of massive shears for cutting the bars, when elongated by lamination, into short lengths. In the rolling room there are also two pairs of annealing ovens, for the purpose of softening the bars when they become hardened by compression, and thus preparing them for another series of rollings in the smaller mills. The steam-engine which gives motion to the machinery of the rolling room is of forty horse-power, and on the compound principle. It was constructed and erected by Messrs. John and Edward Hall, of Dartford, in 1858, and is an excellent specimen of the workmanship of that old and celebrated firm.

Thus much of the fitments and appliances of this department; and now let us look to the operations. A truck-load of gold bars is standing beside the breaking-down mill, and the machine is in motion. The overman having ascertained by the index that the mill is rightly "set," now handles a bar of gold and offers its end to the rolls. It is quickly

* From the Latin word *scisido*, to cut.

† It is, perhaps, scarcely necessary to describe the process of assaying gold or silver at present, as it will have to be referred to again in the last chapter of the series, when treating of the trial of the pyx.

accepted, and passing between the rolls emerges at the other side of the mill a thinner and a longer piece of gold. Another bar follows, and then another, and another, and so on, till the whole batch have been thus acted upon. A workman, properly stationed, receives the elongated bars as they are ejected from the mill, and deposits them on an iron-faced table by its side. The rolls are now made to approach more nearly, and again the bars are squeezed. A re-adjustment and more rolling makes them longer and yet more thin. They are then taken to the shears, cut into gauged lengths, placed in copper tubes, and deposited in the ovens for annealing. Thirty or forty minutes suffices to soften them, and then they are cooled by immersion. Next they are advanced to smaller mills, and by repeated pinchings become exceedingly attenuated. In short, the term "bars" would now be a misnomer; they are mere straps, or "fillets," as they are termed at the mint; and having been brought to a gauged thickness, slightly beyond what is necessary for making them yield planchets or blanks for sovereigns, they are carried to the balance for re-weighing, and the work of the rolling room for the present is done. Thus it fares with silver and with bronze bars; and, as weighing began, so it concludes the day's proceedings.

(*To be continued.*)

THE RICHARDSON PROCESS.

VERY few, perhaps none, of our readers will be aware of what we signify by the title at the head of this paper; and without taking a roundabout way at explaining, we shall at once briefly state that its object is to improve the malleable iron manufacture. We feel certain, therefore, that at a time like the present, when ordinary commercial brands, both of English, Welsh, and Scotch make, are being viewed with some disfavour by several of our great users, for reasons which we need not here enter upon, that any simple and effective process for improving the quality of puddled iron will be looked at with eagerness.

Mr. Richardson had long reviewed the defects of the ordinary puddling process, as well as those belonging to Bessemer metal, and one of his objects was to produce in the puddling furnace a metal that should possess all the qualities of the best merchant iron, namely, ductility, high tenacity, capability of welding, freedom from phosphorus, &c. The separation of phosphorus, if we rightly understand it, Mr. Bessemer himself has not yet been able to effect, and the presence of which, it is believed by most of our ablest metallurgists, is the cause of that brittleness and difficulty of welding that, so far, has been a serious drawback in Bessemer metal.

The Bessemer converter had shown the most rapid manner of separating the carbon and some other impurities that we have yet had presented to us; still, the phosphorus had failed to be separated by it. This fact evidently indicated that in the puddling furnace there must be some other cause at work which enabled it to be got out, that did not present itself in the converter; it was unmistakable, in fact, that the powerful injection of oxygen failed to separate the whole of the phosphorus.

Many chemists have turned their attention towards discovering what other influence was brought to bear on this element in the puddling furnace. The problem, however, has, to the best of our knowledge, as yet remained unsolved, although what appears to be an extremely probable theory on the point was propounded by Dr. Percy, who conceived that during the actual time of puddling, that is, prior to the period when the iron has "come to nature," no phosphorus is separated, and that it remained combined with the iron until after the iron assumes the condition of pasty masses or lumps, lying scattered in that form, immersed in the molten cinder, prior to being collected in balls. As soon, however, as such lumps are balled together, the upper parts of the balls extend considerably above the surface of the liquid cinder; and Dr. Percy believes that, when so conditioned, "opportunity is afforded for the liquation or sweating out of any fusible compounds of iron and phosphorus that may be present, such as a phosphide."

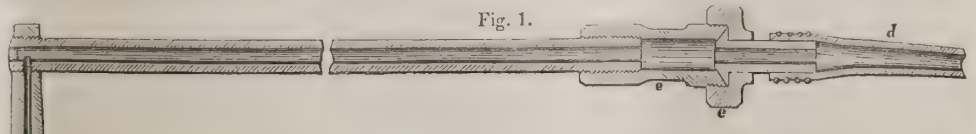
This view of one of our most advanced metallurgists may possibly be correct; but until direct proof is procured it must be reasoned on with caution, as such a theory, if erroneous, is calculated to do quite as much injury in retarding the true road to discovery as it is likely to advance it if correct. If the phosphorus is not got rid of in the puddling furnace in such a manner, it is extremely difficult to assign another cause for it. Chemically speaking, we do not know of the presence of any other agent that appears likely to cause the separation except oxygen, and it is clear enough that phosphorus is not eliminated in any sensible degree by its presence, even at the most exalted temperatures we can employ. If it could be, why is it not separated in the Bessemer converter, where the temperature is considerably higher than in the puddling furnace, on account of the combustion, in this latter case, of some of the iron itself?

Now that we have pointed out, we venture to hope in a clear and intelligible manner, what we and many of our *confrères* believe to be the first great difficulty to be solved by our malleable iron and Bessemer metal producers, we may state that, judging from the experimental researches of Mr. Richardson, and an examination of the samples of iron made under his direction at the works of the Glasgow Iron Company, we believe he has succeeded in introducing a process that must at once greatly reduce the cost, as well as improve the quality, of the metal itself. We do not here state *à priori* that the phosphorus is at present less than in the best brands in the market; still, our opinion is that it is so; and furthermore we make bold to say that, if Dr. Percy's theory is correct, it cannot be present in a larger per-centage. Certainly we have now obtained a metal possessing the advantages of Bessemer metal and puddled iron combined. However, we reserve giving full expression to our convictions until receiving a quantitative analysis, which we had hoped would have been ready for publication along with these remarks.

The specimens which Mr. Richardson has exhibited to a very few only as yet of the great makers are admitted to be of the highest quality, although, we should add, that they were chiefly produced from inferior Scotch pig. In the details of Mr. Richardson's process there is little that is novel *separately*, by which we mean to say that many persons had long since conceived the idea of using certain individual parts; and we know, too, that experiments had been made, but nothing more had been done. Like unto the other great process, it needs only a careful search through specifications of patents anterior to Bessemer's, to show that the idea of taking out the carbon and some other impurities by the powerful injection of oxygen had passed through many minds; while numerous experiments in that direction of chemical investigation were made by other persons years before Henry Bessemer's name was heard of in connection with such a process. Still to him is all the credit due, and to him does the benefit accrue, as the righteous reward for the years of laborious persevering effort which has already semi-revolutionized the world's iron and steel manufacture in some one or two of its specific branches. What Mr. Bessemer has not done, we have good reason to believe the Richardson process will effect. We might, we believe, speak in even more confirmatory terms; still, in the early stage of an invention like the present, which, although it promises so much, partial reticence is perhaps wise. "Facts," at least so says the old proverb, "are stubborn things," and we shall be content to let them speak for themselves. Nevertheless, short as the time is since the first experiments on a practical scale were made here in Glasgow at the works we have alluded to, the results have so rivetted the attention of some of the very few firms to whom the process has been communicated, that one at least, and that a very leading house, is arranging to adopt it without delay.

We may here briefly explain wherein the process consists. The first great fact is, that the necessity for refined or "plate" metal—and therefore the refinery—is dispensed with, the best results having been obtained from charges consisting of pig iron alone. The common pig is piled on the puddling hearth in the ordinary manner, and as soon as it has melted, a blast of atmospheric air of a pressure of 5 or 6 lbs. on the square inch is introduced into its mass by means of a tubular rabble,

Fig. 1.



shown in the engravings, figs. 1, 2, 3, and 4. the blast being led thereto through the flexible pipe, *d*, coupled to the outer end of the hollow rabble handle. The action of the blast prevents the molten iron from closing the holes in the rabble, and, in operating with it, the puddler pushes it about in the molten mass over every part of the furnace with

as much ease as with a common rabble, thus causing a very rapid conversion and elimination of all the impurities that oxygen is capable of separating.

It is not at all probable that any phosphorus is eliminated during this period of blowing in. By the means we have mentioned the iron is brought to nature in a very short time, the rabble being kept in until the mass boils up level with the stopper hole, or, if desired, the blast

Fig. 2

Fig. 3.

Fig. 4.

may be kept in until the iron assumes the pasty condition, a period ranging from about six to nine minutes. As soon as the blast is withdrawn, the charge is stirred about in the ordinary way by a common rabble until the iron has separated from the cinder in lumps, after which it is collected and balled up in the ordinary manner, the balls being allowed to remain in a sufficient time to permit the *probable liquation or sweating out of the phosphides of iron*, after which the iron is shingled and rolled into bars, plates, or uses in the ordinary manner.

Now, at a *prima facie* view, we can understand that many persons would feel inclined, reasoning from previous experimental investigations, to conclude that there is but little in the process. We, however, merely ask them to carefully reflect on what Bessemer has shown to be the rapidity with which carbon, silicon, &c., are eliminated in his converter. In this new process we have the same rapidity of elimination produced in the puddling furnace, in place of the present slow-going separation caused by the licking over the surface of the charge of a reducing flame, and that effected from the addition on the bottom of certain oxidized compounds of iron.

Whilst thus we are now in possession of the means of converting pig into malleable iron in the puddling furnace with the rapidity of the Bessemer converter, we also have reason to believe that we dispossess ourselves of the great disadvantage of having to finish the iron with the phosphorus still in it; we, in fact, have now combined great rapidity of conversion along with the advantage of being able to finish our metal as puddled iron.

Supposing, however, that in regard to the question of phosphorus, and possibly sulphur, that there is no more eliminated than in the ordinary puddling process, the value of the new process remains almost unaffected, as the saving in time shown by the appended table of results in producing finished iron is of itself enough to set our ironmasters agoing; and surely some such cheapening in the production of first materials is really wanted, now that the miserable *laissez-faire* practice of our home manufacturers in the paths of true improvement is causing them to be beaten in the race of competition by other nations whom we have hitherto looked upon as mere followers at a remote distance. We dare hardly speak our convictions as to the natural, and shall we add, however stern it may appear, just sequence that must inevitably follow this unreasoned prejudice and neglected far-sightedness at home. The change to better order must be made at once, if at all, or it will be too late; and we as journalists, having it as a special duty to bequeath our countrymen, are morally bound not to be silent to the facts that are so patent to every enlightened mind. The process we refer to is, in our humble conviction, destined to work great good to our own manufacturers, if they will away with irrational bias. We strongly recommend it to their serious consideration.

TABLE OF SOME OF THE EXPERIMENTS.

Date of Experiment, and Number of Furnace.	Weight of Charge.	Charge Composed of	Time of Charging.	Iron Melted at	Blast put in at	Blast on till	First Ball out.	Last Ball out.	Time Occupied from Charging until the Iron was Finished.	Yield.	Diminution of Charge.	Remarks.
	cwt. lbs.		hrs. min.	hrs. min.	hrs. min.	hrs. min.	hrs. min.	hrs. min.	hrs. min.			
May 30, 1867. Furnace No. 17.	4 0	Pig iron exclusively.	7 0	7 27	7 28	7 36	8 4	8 8	1 8	Not ascertained.	Not ascertained.	
June 11. Furnace No. 17.	4 0	Pig iron exclusively.	6 12	6 42	6 43	6 47	7 18	7 22	1 10	cwts. qrs. lbs. 3 3 14	cwts qrs. lbs. 0 0 14	Three rabbles used, to prevent any one rabble becoming too hot.
June 11. Furnace No. 17, refettled.	4 0	3 cwt. pig iron, and 1 cwt. refined or plate metal.	7 30	8 1	8 1·5	8 6·5	8 35	8 40	1 10	3 2 14	0 1 14	Same number of rabbles used as in the preceding experiment.
June 13. Furnace No. 17.	4 0	Common pig, of the worst quality used in the works for a long time.	6 5	6 35	6 35·7	6 43	7 16	7 20	1 15	3 2 7	0 1 21	Three rabbles used.
June 13. No. 17. Furnace refettled and again charged.	4 0	Same as in the preceding experiment.	7 30	8 3	8 4	8 12·5	8 36	8 41	1 15	3 3 18	0 0 10	Five rabbles used.
Means,	4 0	"		Mean time of blowing in, 6·36 minutes.					1 11·4	3 3 27·25	0 1 0 75	The rabbles are very little affected, and, therefore, will last a long time.

Now an inspection of the foregoing table of results shows at least a saving of more than a third of the time used in puddling a charge over the old process, and it also shows a better yield per charge, besides indicating that no advantage worthy of note, in point of time, is gained by using a proportion of refined or plate metal, clearly pointing out that the refinery and its expenses may be done away with.

The time for working the charge in the last two instances is longer by a few minutes than the preceding, on account of the high degree of impurity of the iron operated with; otherwise, in the first experiment, wherein the charge was of a better quality of pig, the time per charge is shorter than in the second case, where one-fourth of the charge was refined metal. We may add that the results given in the foregoing table are only a few out of numerous others similar.—V. D.

LOCOMOTION IN THE ATMOSPHERE.

BY A MEMBER OF THE AERONAUTICAL SOCIETY OF GREAT BRITAIN.

(*Continued from p.* 79.)

WITHIN the last seven years we find that the *Patent List* chronicles no less than twenty-five or twenty-six different methods by which we were to have been able to fly through the atmosphere, and to subject it to the will of man, but it is needless to say that their utility has failed to be proved; for instance, patents and provisional protections have been granted to eleven contrivances to fly by means of balloons (?), ten different arrangements to fly by means of wings and outstretched planes, and three to raise and transport us by means of the screw. As none of them have yet shown their utility, it is of no use examining their several merits. We have no lack of expounders on the laws

which govern flight, but one of our most indefatigable is Dr. J. B. Pettigrew.

This gentleman is of opinion that if flight is ever accomplished, it will be by means of the screw, which screw must combine in itself (when working) the action of the wing as well as be assisted by the balloon. In his lecture in March last, before the Royal Institution, he says:—

"Finding that no marked improvement has been made in the balloon since its introduction in 1782, we naturally turn our attention to some other method of traversing the air; and here I would add my independent testimony in favour of the helice or screw, not only as a lifting power, but also as a propelling power.

"When I commenced my inquiries into the structure and uses of wings, I was early struck with the curious manner in which they are twisted upon themselves, and how they are rotated on and off the wind during flexion and extension, after the manner of screws; and without knowing (for the subject of artificial flight is not much in my way) that the helice had been proposed as a means for raising inanimate bodies, I had actually constructed a double screw, with a view to testing its efficacy in this respect.* I have therefore unwittingly laid anatomy and physiology under contribution in support of what I find is not a new doctrine. I was impelled in this direction by detecting the principle in nature, and from knowing that a body to rise and progress in the air need not necessarily be lighter than it; in fact, that the balloon is constructed on a principle diametrically opposed to that on which the bat, insect, and bird is constructed, and is from this circumstance open to serious, and, in some respects, insuperable objections.

"The efficacy of the screw in water is well known, and the action of the child's toy, usually called the spiralifer, will illustrate its utility as applied to the air. This toy, for a toy it has hitherto been, consists of two inclined planes, produced by simply twisting the enveloping wires in opposite directions. It therefore represents the most primitive form of screw. This apparatus, simple as it may appear, curiously enough furnishes the mechanical appliance by which a body may be elevated, or elevated and carried in a horizontal direction at one and the same time. By applying the necessary power, the spiralifer can be made to act vertically or horizontally, or at any intermediate angle, so that we have in it an easily regulated and perfect driving power. The position taken up by the advocates of the screw is the reverse of that occupied by the advocates for the balloon, so that the aeronaut promises at no distant day to be fairly impaled on the horns of a dilemma, by having on the one hand, a motor power which (because of the space occupied by it) no human ingenuity can direct; and on the other, a thoroughly manageable and docile elevating and driving apparatus, minus an adequate motor power. The problem of flight will probably be solved by one employing a certain proportion of gas to assist him in overcoming the inertia of his machine while he uses the screw as a propeller and partial elevator. Of the two systems propounded, if they be judged separately, I incline to that which proposes to employ the screw both in elevating and propelling, and this for two reasons:—1st, Because the screw, or a modification of it, is the instrument by which, as I have shown, the insect, bat, and bird rises and progresses; and 2nd, Because a certain degree of weight is necessary to overcome the air and make it useful for the purposes of aerostation."

Dr. Pettigrew is a very able and learned philosopher; his paper abounds with original information and most interesting facts; the manner in which he treats of the bird is specially commendable, and there is no doubt that a published treatise from him on the subject would be well received by the public. Unfortunately Dr. Pettigrew is not an engineer. Like many others, he speaks of making and employing an engine as yet unknown for power, and of raising a machine by means of such a motive power, as if it could be done by the mere uttering of a word. The four mechanical powers, the screw, the lever, the pulley, and the wedge, are means without which no human skill could construct a machine of any kind. The screw exists in fishes, worms, snakes, &c., only; the lever exists in the bird and in most of the animals moving on *terra firma*. The lever as in the wing is a perfectly independent body, and has no connection with the screw whatever; if it had been said that *the bird, bat, or insect*, &c., *wedges its way through the atmosphere*, then it would have been perfectly correct; that the wing assumes different shapes and contortions when in motion is undoubtedly true, but as regards the making use of the screw or any other power to rise perpendicularly off the ground is entirely out of the question. A body falling from a position of rest descends 16 feet the first second; and a body leaving the ground vertically would (unless the force which impelled it be continued) on reaching its maximum height, turn and fall with equal velocity. We find then that a machine constructed according to Dr. Pettigrew's theory, weighing only one ton, would require a motive power within itself capable of working up to about one hundred and thirty horse-power; which machine having obtained a certain height would require to work with about seventy horse-power to maintain its position.

This machine would have to utilize its remaining power to obtain the start. It is by no means pretended that seventy horse-power is constantly requisite, for as the speed increases so does the maintaining power at first requisite diminish; it is, moreover, an impossibility to calculate on a large machine from the results of a model worked by a steel spring and clock-work. Where is the screw or helice which will lift a ton *perpendicularly* from the ground, carrying its own motive power, fuel, stores, &c., &c.? Where is the screw which in rotating will grasp the atmosphere firmly and rise, instead of merely drawing down a current of air? For instantly the air is put in motion it will continue to flow with a momentum equal to the screw's revolution, returning only a very partial result for the enormous power expended. The screw, when working in air, must lay hold of it as firmly as it does the water, otherwise the results will be very insignificant. The enormous difference of the results obtainable in these two elements is, that in the one (water) the body floats in it, and has to overcome a resistance which is nearly equivalent to that of screwing through a compact body, it has no tendency to fall back, for that which it gains it retains; in the air it is the very reverse, for until the body has received a certain forward impulse equal to the screw's revolution, it will never rise at all; another objection is that the long blades of the screw, and they must be exceedingly long, have to support the whole weight of the body.

To fly by means of the screw is not an impossibility; it is possible if the following obstacles in the way could be overcome:—First, the enormous power requisite to supply the body with a constant maintaining power, in lieu of an outstretched surface; second, the incurable slip, because from the moment the screw is set in motion it but draws down a useless current of air; third, the danger of a shaft in revolution having to lift such a weight, and sticking fast; fourth, to get a start which will diminish the slip to almost *nil* and give the accelerated motion; fifth, to obtain the requisite motive power within the space and weight.

Those who wish to study this subject any further, cannot do better than follow up these extracts taken from the learned doctor's lecture on the various modes of flight. Speaking of hollow bones and air cavities he adds—

"When we have said that cylinders and hollow chambers increase the area of the insect and bird, and that an insect and bird so constructed is stronger, weight for weight, than one composed of solid matter, we may dismiss the subject, flight being, as I shall endeavour to show by and by, not so much one of weight as of power properly directed, *i.e.*, power directed on strictly mechanical principles. Those who subscribe to the heated-air theory are of opinion that the air contained in the cavities of insects and birds is so much lighter than the surrounding atmosphere, that it must of necessity contribute materially to flight, but the quantity of air imprisoned is, to begin with, so infinitesimally small, and the difference in weight which it experiences by increase of temperature so inappreciable, that it ought not to be taken into account by any one endeavouring to solve the difficult and important problem of flight." In the previous part of this paper we spoke of the wings of birds and insects; the following are Dr. Pettigrew's remarks on this point:—

"The wings of insects and birds are, as a rule, more or less triangular in shape, the base of the triangle being directed towards the body, the sides anteriorly and posteriorly. They are also conical on sections from within outwards and from before backwards, this shape converting the pinion into a delicately graduated instrument, balanced with the utmost nicety to satisfy the requirements of the muscular system on the one hand, and the resistance and resiliency of the air on the other. While all wings are graduated as explained, innumerable varieties occur as to their general contour, some being falcated or scythe-like, others oblong, others rounded or circular, some lanceolate, and some linear." Further on he continues—"So that it might

* This screw had four fans or blades, two of which revolved from left to right, the remaining two from right to left. This I found to be necessary to prevent rotation in the driving apparatus, which consisted of a steel spring and clockwork.

naturally be asked, Do the several orders of wings act according to a common principle, or does each wing act according to a principle of its own? There can, I think, be but one answer to this question. All wings obtain their leverage by presenting oblique surfaces to the air, the degree of obliquity gradually increasing in a direction from behind, forwards and downwards, during extension, when the sudden or effective stroke is being given, and gradually decreasing in an opposite direction during flexion, or when the wing is being more slowly recovered preparatory to making a second stroke. The effective stroke in insects, and this holds true also of birds, is therefore delivered *downwards and forwards*, and not, as the majority of writers believe, vertically, or even slightly backwards. This arises from the curious circumstance that insects and birds when flying actually fall through the medium which elevates them, their course being indicated by the resultant of two forces, viz., that of gravity pulling vertically downwards, and that of the wing acting at a given angle in an upward direction."

Dr. Pettigrew endeavours to show that the wings of birds rise at an angle which we have not yet observed:—"The angle at which the wing acts most efficaciously as an elevator, as proved by an examination of the pinion of the living insect, bat, and bird, when fully extended and ready to give the effective stroke, is an angle of 45° with the horizon." So is it with man also when climbing; his limbs are made to enable him to assume that angle or greater with ease, but he very seldom makes use of such power. The pigeon's wing when rising to a house top assumes a great angle, but seldom more than 15° or 20°, if even so much.

We do not make these quotations to criticize the doctor's lecture, but only to lay before the readers of the *Practical Mechanic's Journal* the opinions of the different authorities of the day; and we are compelled to remark on those parts of their papers or lectures when we find inconsistencies with the incontrovertible laws under which aerial locomotion exists. That the wing of a flying creature does assume an angle during flight is undisputed, but simple calculation will show that with the speed at which the wings and body of the creatures travel, the angle of 45° is simply impossible with any of them.

After going very elaborately into the *supposed* shape of the wing, for Dr. Pettigrew evidently looks at the wing in his own light, he concludes that—"The wing of the bird may therefore be compared to a huge gimlet or auger, the axis of the gimlet representing the bones of the wings, the flanges or spiral thread of the gimlet the primary and secondary feathers. As the degree of rotation made by the bones of the forearm and hand during extension amounts as nearly as may be to a quarter of a turn of a spiral, it follows that in flexion the wing presents a knife-like edge to the wind; whereas in extension the curtain of the wing is rotated in a downward direction until its anterior or concave surface makes an angle of 45° with the horizon. From this description it will be evident that by the mere rotation of the bones of the forearm and hand the maximum and minimum of resistance is secured, much in the same way that this object is attained by the alternate dipping and feathering of an oar." If we do not greatly mistake, the theory of the oar is a very different thing altogether, for it is the quarter action or turn of the screw, and the wing cannot possibly be more than half of that again when working to its fullest extent.

An anonymous writer in *Nicholson's Journal* calculates that the common house-fly (*Musca domesticus*) in its ordinary flight makes 600 strokes per second, and that it advances 25 feet; but that the rate of speed, if the insect be alarmed, may be increased six or seven fold, so that under certain circumstances it can outstrip the fleetest racehorse. Indeed! this is carrying the sublime to the ridiculous; according to him, when that miraculous fly is alarmed it will make 4200 strokes per second, or 252,000 per minute, and advance 175 feet per second, or 10,500 feet per minute. This is 2 miles per minute, or 120 miles an hour!! What are the proportions of this fly?

Time and space permitting, we shall enter into the calculations on which the different theories are based, as well as the at present proposed aerial machines.—M.

KRUPP'S CAST-STEEL WORKS AT ESSEN, RHENISH PRUSSIA.

This establishment, commenced forty years ago, has gradually been developed and increased, so that at present the works cover a surface of about 450 acres, of which one-fourth are under roof. The number of men employed is 8000, besides which there are in the coal mines near Essen, and at the blast furnaces on the Rhine, and at the iron pits on the Rhine and in Nassau, 2000 more. In the year 1866 the products of the works were 61,000 tons, manufactured by means of 412 smelting, reverberatory, and cementing furnaces; 195 steam engines, ranging from 2 to 1000 horse-power; 49 steam hammers, with hammer blocks of from 1 cwt. to 50 tons; 110 smiths' forges; 318 lathes; 111 planing machines; 61 cutting and shaping machines; 84 boring machines; 75 grinding machines; and 26 sundry and special tools.

To carry out the production of the cast-steel manufactures, 1000 tons of coal are consumed daily, exclusive of the considerable consumption of coal in the production of the raw iron from which the steel is made. The products of these works are distributed over Europe, North America and several South American states, East India, China, Japan, &c., and their annual value amounts to more than £1,500,000. For the supply of the several steam engines there is required 120 steam boilers, which in the twenty-four hours evaporate 150,000 cubic feet of water into steam of four atmospheres in pressure. There is also belonging to the establishment gas works, making a supply for more than 10,000 gas burners. The workshops are in operation during the night, and in the shortest day 400,000 cubic feet of gas were consumed in the twenty-four hours. The works are in communication with three principal lines of railways, and within the establishment itself are laid 15 miles of rails, which traverse them in all directions, and serve for the use of six locomotives and 150 wagons belonging to the establishment. These celebrated works have sent to the French Exhibition a remarkably fine collection of articles of their manufacture; and we think it will be interesting to our readers to give a detailed description of the principal ones. Altogether they weigh nearly 170 tons, and have a total value of about £40,000.

A steel block, cast from crucible steel, having a diameter of 56 inches, and weighing 40 tons. In the centre of the height there are pieces that have been cut and broken out, in order to show the quality and soundness of the casting. The upper end of the block is forged into an octagonal shape, and the centre part of the head of this ingot is fractured, so as to demonstrate the quality of the metal. The half of the head of the block is polished to indicate the fineness and density of the metal. This casting is intended to be forged under the 50-ton hammer into a marine crank shaft. All cast-steel productions of this establishment, with the only exception of the disc centres for railway wheels, are made from such ingots of a greater or lesser weight, and of a round or square section, and then forged into their respective shapes.

Patent cast-steel railway tyres of crucible steel, without welding. The cast-steel tyres form a very considerable portion of the Krupp manufactures, and the yearly production is nearly 40,000, of which over one-third are for English, Indian, and American railways. The invention for this process of manufacture dates from the year 1853. The process of manufacture is this:—Large ingots of cast steel are forged out into flat lengths, from which are cut rectangular pieces, corresponding with the weight of the proposed tyre. These pieces are forged into bars, which are split down the centre to within a certain distance from each end; wedges are then driven into the slot, and the bars gradually opened out, and worked under the hammer into a ring, which are ultimately completed into tyres in the rolling mills.

A cast-steel axle, of crucible steel, with forged iron wheel centres and cast-steel tyres, without a weld (of same description as the tyres just before described); weight, 1896 lbs.

A cast-steel axle, of crucible steel, with cast-steel disc wheels; these last are not made by either forging or rolling, but cast directly into shape. The total weight is 1623 lbs.

A cast-steel locomotive crank axle, of crucible steel, with cast-steel disc wheels, of 6 feet diameter, upon the model of the Northern Railway of France. The axle is forged from a large cast-steel ingot; the wheels are cast direct into shape. The weight of the axle alone is 1835 lbs., and the weight of the whole 8074 lbs.

A cast-steel junction ring, of crucible steel (angle ring), for steam boilers. These are made without weld, and upon the same method as the tyres. The weight is 483 lbs., and the diameter 96 inches.

A cast-steel double crank shaft, of crucible steel, for a Transatlantic screw steamer. This was forged from a massive ingot of 27 tons, under the 50-ton hammer. Its weight in its present finished condition is 9¼ tons; its length 25 feet and its diameter 14 inches. This

establishment has supplied a large number of such marine shafts of various weights; principally to the Bremen Lloyd, the Hamburgh and New York Steam Packet Company, the Trieste Lloyd, the Royal Mail Steam Packet Company, the City of Dublin Company, and others in England and France. Krupp's charge for these shafts ranges from 2*s.* 1*d.* to 3*s.* 6½*d* per 1⅕ lbs. avoirdupois (from 500 to 850 francs the 100 kilos.), according to their form and the amount of finish.

A cast-steel rail 50 feet long doubled over in the middle until both sides meet. Cast-steel rails form one of the chief objects of manufacture of these works. They are made from a second quality of cast steel. It is well known that the durability of steel, as compared with iron, is in an extraordinary ratio in favour of steel rails.

A cast-steel 1000-pounder rifled breech-loading gun, resting upon a cast-steel carriage, the whole made of crucible cast steel. This splendid gun has attracted great attention; it is intended for the arming of coast batteries against the attacks of plated ships. It consists of an inner tube upon which are shrunk cast-steel rings. The inner tube forms the important part of the gun, and weighs, in its present condition, 20 tons, having been forged from a massive ingot of 40¼ tons, and forged under the 50-ton hammer. The difference in the weight of the tube and ingot has been lost through the usual top or head that is cut off, through forging, turning, and boring. The cast-steel rings form a three-fold layer at the powder chamber, and at the muzzle portion a two-fold layer. These rings weigh together 30 tons, and have been manufactured in a manner similar to the tyres, from massive ingots, and without welding. The system of breech-loading is Krupp's patent.

The following list gives the particulars of this monster piece of ordnance:—

Total weight of the gun, 50 tons.
Preponderance, 1500 lbs.
Diameter of bore, 14 inches.
Total length of gun, 210 inches.
Number of rifle grooves, 40.
Depth of rifling, 0·15 inches.
Twist of the rifling, 980· and 1014·4 inches.
Weight of the solid shot, 1212 lbs.
Weight of the shell, 1080 lbs., made up as follows:—

	lbs.
The cast-steel shell,	843
The lead jacket,	220
Bursting charge,	17
Total,	1080

Charge of powder, from 110 lbs. to 130 lbs.

This gun has been in progress of manufacture, day and night, for sixteen months, without interruption. The railways possessed no wagons which were strong enough to convey it, so that the establishment was compelled to construct its own wagon, which is manufactured entirely of steel and iron, and rests upon twelve wheels. The total weight of this wagon is 24 tons. This cannon rests upon a steel carriage of the weight of 15 tons, and together they work upon a turntable of the weight of 25 tons. The turntable was not sent to the Exhibition, because sufficient space could not be afforded for it. The gun carriage slides smoothly upon the turntable to the checks at the back stays, at each discharge of the gun. The mechanism for working the gun is such that one or two men can quickly and easily elevate, depress, and turn the gun, and can with the greatest speed and certainty follow and cover any passing plated vessel. The price of the gun alone is £15,750; with the carriage and turntable, £21,750.

The largest gun sent by the British Secretary of State for War is a 12-inch wrought-iron muzzle-loading rifled cannon, built up with a cast-steel tube, and eight coils of fibrous wrought iron. It weighs 470 cwt., and its projectile 600 lbs.; the charge weighing 70 lbs.

A forged trunnion ring of cast steel, for 1000-pounder gun. It was forged from one solid cast-steel block, in a manner similar to the manufacture of tyres without a weld, and its weight is 5¼ tons.

A rifled breech-loading cast-steel gun, of crucible cast steel, forged from one massive ingot under the 50-ton hammer, with separate trunnion ring, which has been forged into shape without welding. The weight of gun, including breech apparatus, is 12¼ tons; diameter of bore, 9 inches; number of rifled grooves, 32. The total length of the gun is 80 inches; the weight of the solid shot is 330 lbs.; that of the shell 275 lbs.; and the powder charge 40 to 45 lbs. The breech apparatus is upon Krupp's patent cylindro-prismatical wedge system. From this gun has already been fired 120 rounds with the full charge of 45 lbs. of powder. We are informed that the establishment has manufactured and delivered already 3500 cast-steel guns, having a value of over £1,050,000, and that they have on order, for European and other governments, for immediate delivery, 2200 cast-steel guns of a value of over £600,000. About $\frac{19}{20}$ of the total number of 5700 cast-steel guns are rifled breech-loaders, and range in calibre from 4-pounders up to 300-pounders, a few being also 600-pounders and 1000-pounders.

A rifled breech-loading cannon, of crucible cast steel, forged from one massive ingot under the 50-ton hammer. The weight of this gun, including breech apparatus, is 4¼ tons; the diameter of bore 6 inches; the number of rifled grooves 24. The total length of the gun is 144·5 inches; the weight of the solid shot is 90 lbs.; and the powder charge 10 to 12 lbs. The breech apparatus is upon Krupp's patent wedge system. This gun has been fired 100 rounds, with the full powder charge of 12 lbs.

A 6-pounder breech-loading rifled gun, of crucible cast steel, forged from one ingot. The weight of this gun, including breech apparatus, is 948 lbs. The length of the gun is 78 (Rhenish) inches; and the diameter of bore 3·5 (Rhenish) inches. The number of rifled grooves is 18; the weight of the charged shell is 14·8 lbs.; and the charge of powder 1¼ lbs. The system of breech apparatus is Wahrendorff's.

A 6-pounder breech-loading rifled crucible cast-steel gun, forged from one ingot. The weight of the gun, including breech apparatus, is 948 lbs.; the length of gun 78 (Rhenish) inches; the diameter of the bore 3·5 (Rhenish) inches. The number of rifled grooves is 18; the weight of the charge shell is 14·8 lbs.; of the powder charge 1¼ lbs. The system of breech apparatus is the Prussian double wedge.

A rifled 4-pounder breech-loading gun, of crucible cast steel, forged from one ingot. The weight of the gun, including breech apparatus, is 605 lbs.; the diameter of the bore is 3 Rhenish inches; the number of rifled grooves 12. The total length of the gun is 74 Rhenish inches. The weight of the charged shell is 8½ lbs.; and of the powder charge 1 lb. The system of breech apparatus is Krupp's patent semi-cylindrical wedge, fitted with Broadwell's ring. This gun rests upon a wrought-iron carriage, and it is the property of the Prussian War Department. It has, together with several other similar Krupp's guns, been submitted by the Prussian Minister of War to the extremest test, there having been fired from them several hundreds of shots, with gradually increased charge up to 3¾ lbs. of powder, and 122 lbs. weight of shot. In no instance have the guns or breech apparatus been injured; and this gun left the proof in its present condition.

A rifled muzzle loader, of crucible cast steel, on the model of the French mountain gun, weighing 215 lbs, and throwing a shell of 8½ lbs.

In addition to these objects there are boiler plates of cast steel; a rolled cast-steel plate 30 feet long, 19 inches broad, and $\frac{5}{8}$ of an inch thick, for girder constructions, &c.; cast-steel railway springs; hardened and polished rolls of cast steel.

PARIS EXHIBITION.

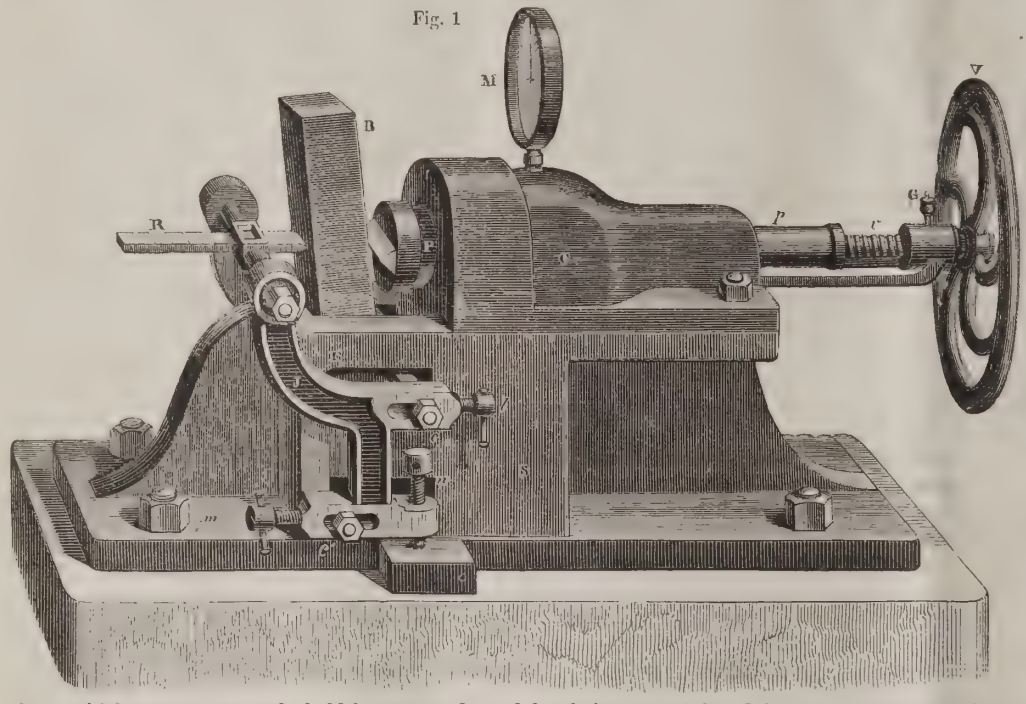
THE APPAREILS STERHYDRAULIQUES OF MESSRS. DESGOFFE AND OLLIVIER.

In an outer corner of one of the passages leading across the French division, and connecting the inner and outer avenues of the great machinery cincture of the Exhibition building, is to be found a small area in which are exhibited various hydraulic testing apparatus of great perfection and elegance of arrangement, besides, as it appears to us, special adaptability to the ends intended. The exhibitors are Messrs. Desgoffe and Ollivier, of 6 Boulevard de Vaugirard, Paris; and we are informed that some of the apparatus they exhibit, although only on a small scale, has been supplied by them for use in some of the state departments, under the control of the Minister of Marine.

The first object we shall notice is a press for testing the resistance of bodies to flexion. It is illustrated in the annexed woodcut, fig. 1, and consists of a handwheel, v, which, on being rotated, actuates the screw, *v*, and consequently causes the piston, *p*, to recede or advance within its cylinder. G is an oil cup. By the movement of the small piston, *p*, the larger piston, P, is advanced or withdrawn through a distance inversely proportional to the relative areas of the two pistons. The

body of the press, C^1, is provided with a manometer or pressure gauge, M, for registering the compression within the cylinder; and to the outer end of the large piston, P, a knife edge is attached, which presses against the bar under experiment. B is the experimental bar. It is supported against the knife edge on the piston, P, as shown, as well as by two

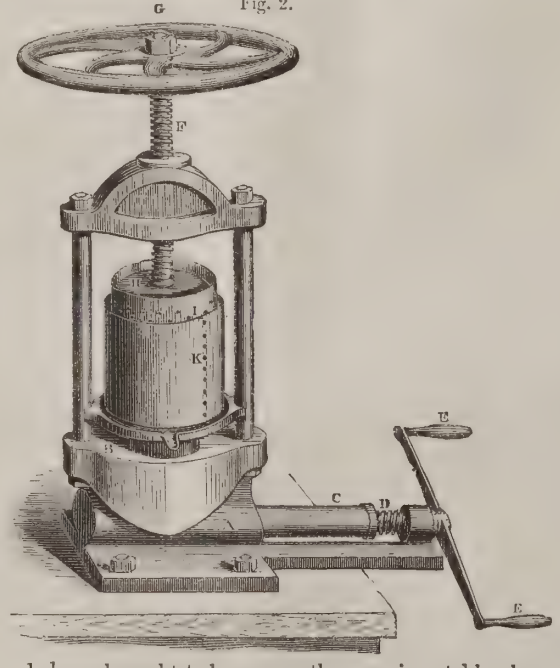
Fig. 1



others, which are very securely held in grooves formed for their reception in the bars, by means of the bolts, c, c^1.

The flectometer, E, is composed of the two knife edges or blades, of which the retaining bolts, c, c^1, are seen, and these are rendered secure by the two cheeks, J, with an axle or bar, A, which carries a finely divided scale, R, that slides in the opening provided for it, as shown, and to which a vernier is applied. The two knife edges sustained by the

Fig. 2.



bolts, c and c^1, are brought to bear upon the experimental bar by means of the adjusting screws, l and m. The scale, R, is made of bronze, and furnished at its extremity with a piece of tempered steel, which constitutes the knife edge on which the outer edge of the bar under experiment bears. The blades, c, c^1, sustain the effect of the force used to ascertain the various deflections, and the screws, l and m, are provided to cause the bar to be held in contact with these blades. The screws, n, n^1, regulate the position of the flectometer, and, at the same time, the points of support (*points d'appui*) of the entire system, at the moment when the experimental bar inclines itself, in consequence of the penetration of the knife edges.

In this apparatus the experimental bar is held by two blades, as in the apparatus of Monge. The deflection of the bar is produced by the knife edge of the large piston, P, bearing upon it, as is evident enough on a careful inspection of the engraving; the flectometer being composed of two knife edges, one of which remains in contact with the bar, so that it cannot be inclined without bending. In consequence of the penetration of the blades into the bar, all the system swings in following its movement. It is not until this instant arrives that the bar begins really to bend and push the scale, R, the movement of which is easily read by means of the vernier attached, which gives the exact extent of bending.

The arrangement of this flectometer is said to avoid the sources of error inherent to machines for the same purpose hitherto used, in the particular fact that it is not possible to take into the estimate of deflection the displacement produced from the penetration of the blades. The apparatus we have now illustrated is used in the department of the Minister of Marine to measure the resistance to bending of bodies composed of malleable and cast iron and steel.

Another press which the same firm exhibit, and which we regret we have not obtained drawings of in time for illustration in the present part, but hope to do so in our next issue, is of rather singular construction, in so far as the mode of displacing the hydraulic piston is concerned. As far as we were able to inspect this press, it appeared to us that the hydraulic cylinder always had the same quantity of liquid in it, and the piston or ram is displaced by winding into the lower part of the cylinder a cord, a pulley being placed therein for that purpose, so that as the cord is wound in the capacity of the cylinder becomes diminished, and in consequence a displacement of the liquid and piston ensues. When it is required to withdraw the piston, the cord is wound out of the cylinder. The cord used appeared to be a line of catgut, about 0·25 an inch diameter as measured by the eye. We cannot say that we could recommend such a mode for producing hydraulic pressure, and should in all cases prefer a well-made force pump, although, no doubt, catgut, which is of a very hard nature, may answer very well for moderate pressures when some two or three inches of its length (the part upon which the action of the press takes place) is led through, and therefore protected by, a well-made stuffing box, as it appears to be in the press we examined. Altogether this arrangement appears worthy of notice more especially for its ingenuity, rather than as any improvement over what had been done before.

The same firm also exhibit a laboratory press, shown at fig. 2. It consists of a receiver, A, full of oil, into or from which the pressure piston, B, is advanced or withdrawn by means of the screw, D, actuated by the lever handles, E. The larger piston, B, is put in motion by the displacement produced by the smaller piston, C, and their respective motions are inversely proportional to their areas. At the upper end of the framing the ram, F, is situated; and being provided with a hand-wheel, G, at its upper extremity, and a plate, H, at its lower extremity, it is destined to be used for the purpose of giving an initial pressure, prior to using the hydraulic pressure in operating on the substances under treatment contained within the perforated receiver, I. In this way the time saved in bringing up the initial pressure by means of the hydraulic ram is diminished, and the pressure of the ram can afterwards be added to by aid of the hydraulic apparatus attached. The

PARIS EXHIBITION 1867

COUPLED Wᴹ WOOLFF ENGINES.

CORBRAN SONS & LEMARCHAND, ENGINEERS,

ROUEN.

Fig 1.

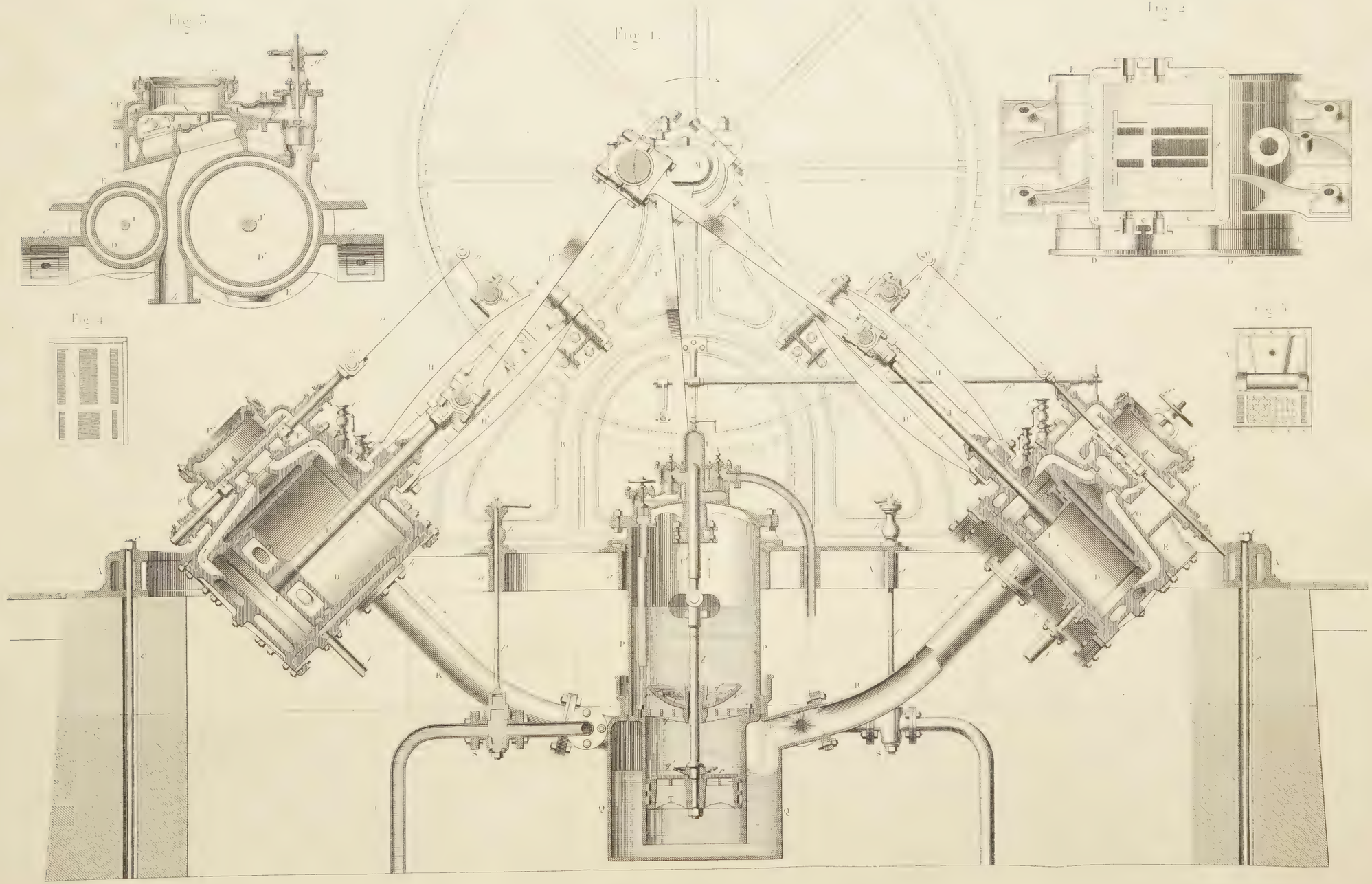


Fig 2.

Fig 3.

Fig 4.

Fig 5.

Scale 1/20

Patent Offices. 47 Lincoln's Inn Fields London and 166 Buchanan St Glasgow.

Armengaud aîné.

Fig. 2.

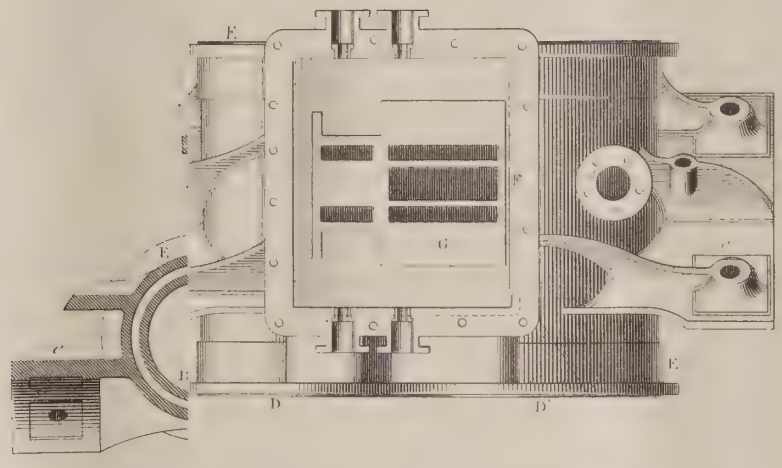


Fig 4

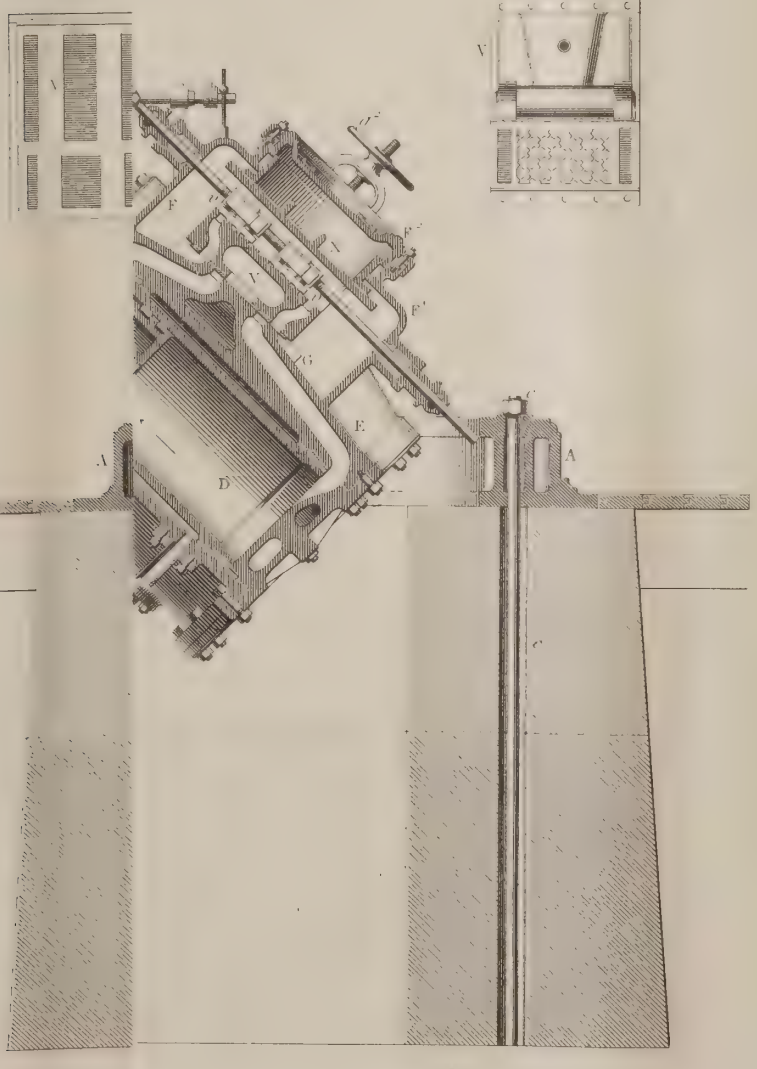


Fig 5.

Patent Offices. 47 Lincolns Inn Fie
and 166 Buchanan St Gla

Armengaud aîné.

press, as shown in the engraving, is intended for laboratory purposes, such as the separating of liquid from solid substances. When the pressure is brought to bear on a substance the liquid naturally spirts out through the perforation in the can, I; to prevent this, and cause the collection of the liquid, an unperforated concentric case, K, is placed around the can, I, so that as the liquid escapes it trickles down and is collected in the annular receptacle, from which it runs into a vessel placed in front of the lip to receive it. We shall illustrate some of the other apparatus exhibited by Desgoffe and Ollivier.—V. D.

PARIS EXHIBITION, 1867.

COUPLED WOOLFF ENGINES WITH INCLINED CYLINDERS.

(*Illustrated by Plate* 9.)

A MODEL of the engine which forms the subject of our Plate this month is exhibited by the makers, MM. Corbran, jun., & Lemarchand, of the Chartreux Work, near Rouen. It contains many points worthy of notice. We are indebted to M. Armengaud's *Publication Industrielle* for the Plate and description of this engine.

Messrs. Corbran & Lemarchand's engine consists of two coupled engines of large size, both provided with double inclined cylinders, and disposed on each side of the main shaft, to which they transmit their united motion, there being but one vertical condenser common to the two engines. It is, in fact, a modification of the Woolff engine, with a large and small cylinder; but instead of being vertical, with a cross beam, strong columns, and a large entablature for the frame, as most of this class of engines are made, it is composed of two pairs of cylinders, disposed obliquely at an angle of 45 degrees, and secured direct to a large bedplate, carrying two large cast-iron standards, which receive both the slides of the piston rods and the bushes for the main shaft.

This arrangement possesses many advantages over the old plan, which will be appreciated by those practically acquainted with the subject. Thus, on the one hand, the necessity for using costly foundations, indispensably requisite with the vertical engines, is obviated, and the space required for them is reduced: again, there is a considerable saving in the cost of erection and construction, which is more prominent in the larger engines; for, as the engines are coupled, they may be made to work at higher speeds, and the mass of cast iron employed may in consequence be much reduced. The new engine of MM. Corbran & Lemarchand meets all these conditions, viz., it effects a reduction in cost as against the cross-beam system for the same nominal horse-power, requires less stone work for its foundation, and works at a uniform speed, so desirable in spinning, power-loom weaving, and similar manufactures.

We believe that to M. Cavé, formerly an engine-builder in Paris, belongs the credit of the first application of inclined cylinders. He applied them forty years ago to a steamboat running on the Seine, the particulars of which were published in the bulletins of La Société d'Encouragement. Several manufacturers have entertained the idea of building engines with oblique cylinders, either for works or manufactures, for river steamboats, or for the larger class of marine steam vessels; and these engines have given good results as regards the management and regularity of the work.

It is, *a fortiori*, equally true of those of MM. Corbran & Lemarchand, but by their arrangement of double cylinders they obtain, in addition to the preceding advantages, greater regularity and an increased saving in the consumption of fuel, for the steam is expanded not merely in the large cylinders, as generally practised in the Woolff engines, but also in the small cylinder, by which the expansive action of the steam is utilized to the utmost extent. By placing the cylinders at an angle of 45 degrees the cranks may be so arranged that when one of the pistons is at one end of its stroke, the opposite one will be at about the middle of its stroke; and notwithstanding that the connecting rods may be of the requisite length, they will necessarily be shorter than in horizontal engines of equal power, and of the same length of stroke. The main shaft being situate in the centre of the engines, and more than six feet from the ground, offers great facilities for the transmission of the motion, which may be effected either directly or by straps or gearing. It is well known that the double-cylinder engines are usually made of such proportions that their performance greatly exceeds their nominal power. MM. Corbran and Lemarchand in this have followed the practice established in Normandy and elsewhere, and make the effective power on the main shaft at least double that of the nominal power; they also construct some engines on the beam system with two cylinders, which, at the speed they work at, may even attain to three times their nominal power. The engine which we are describing built by them, and nominally of 50 horse-power, is really of 100 horse-power, as has been proved by actual trial. The various engines on this system already at work demonstrate that MM. Corbran and Lemarchand have really effected the objects they had in view, and we are satisfied that the model sent by them to the Paris Exhibition will be inspected with interest, as well by the jurors as by mechanical engineers in general.

Fig. 1 (Plate 9) is a vertical section (1-20th size) taken on the one side through the axis of the large steam cylinder of the left-hand engine passing through the centre of the condenser and the air pump, and on the other side through the axis of the small cylinder of the right-hand engine.

It should be observed, that for the sake of symmetry, and in order to effect the proper distribution of the power on the main shaft, the cylinders of both engines have been so arranged, that the larger cylinder of one engine may be almost in the same plane as the smaller cylinder of the other engine, and *vice versa*. Fig. 2 is a plan, and fig. 3 a vertical section of one of the pairs of cylinders with their cast-iron casing and slide box, drawn to the same scale as fig. 1.

The engines are supported on a large and strong cast-iron bedplate, A, cast in one piece, in shape corresponding to a long rectangular frame rounded at its ends, and strengthened at the sides towards the middle by cross pieces, *a*, and a circular piece, a^1, also cast in one piece with the bedplate; the latter receives the condenser and air pump, and the former the small cast-iron pedestals, *b*, the tops of which serve as indicators to show the degree of opening of the injection pipes. This bedplate rests on a correspondingly shaped foundation of ashlar, held securely together by the foundation bolts, *c*. On each of the two sides of the bedplate are securely bolted the two cast-iron open work standards, B, on which are also cast the pedestals of the main shaft, and the supports for the rocking shafts, which actuate the slide valves.

These supports, four in number, are connected and fixed by five bolts. Two strong cast-iron ribbed cross pieces, C, connect the standards, and at the same time serve as supports for the guides of the piston rods. The two pairs of steam cylinders, D D^1, cast separately, are inclosed in the cast-iron jackets, E, having large projections, *e*, planed on the underside, cast thereon, which projections or flanges rest on and are bolted to the ends of the bedplate. These bolts also enter the masonry, and iron wedges are driven in at the ends of the projections or flanges to prevent any vibration. Collars bored to receive the turned flanges of the cylinders are placed in the interior of the jackets, and a packing of cast-iron filings completes the joints. The steam from the boiler circulates in the annular spaces between the jackets and the cylinders before it enters the slide box, and the water from the condensed steam returns to the boiler through the small tubes, *f*, situate near the bottom of the jackets, whilst the steam enters near the top. Each jacket is provided with ports for the arrival of the steam, and outlets for the return of the water, and has cast in one with it the steam pipe, *g*, one-half of the slide box, the slide face of the cylinders, and the eduction pipe, *h*, which conveys the steam to the condenser. The valve box is made in two parts; the one part, F, cast in one piece with the jacket containing the slide face, G, with five apertures on which the slide works; and the upper part, F^1, provided with an aperture of a circular form closed by a cover, F^2, the joint being made by packing (see fig. 2). The joint of the two halves of this slide box is made in the line of the axis of the stuffing boxes, which facilitates the removal of the slide.

The cylinder covers are made double, and the intermediate space may thus be filled with steam as well as the jacket when desired. The bottom covers carry the priming cocks, whilst the top covers are provided with lubricators, *i* i^1, and with stuffing boxes for the piston rods to pass through. To the collar of each of the stuffing boxes there is attached one end of the piston guides, H H^1, which support the heads of the pistons against the thrust of their connecting rods: the outer end of these guides are supported, as before stated, by the cross pieces, *i*, between the two large standards which carry the main shaft. The steam pistons, I I^1, are of cast iron, the body is hollow, and the two parallel bases are joined by ribs; each piston is connected to its rods by a

screw thread cut slightly conical on the piston rods, and screwed into the body of the piston. The piston packing is composed of cast-iron rings, the accurate fitting of which is adjusted by a gradual increase in thickness. The piston rods, J J^1, are of wrought iron, and are adjusted and keyed to the centre of the cast-iron heads, K K^1, which slide between the two guide rods, H H^1, and carry each an oil reservoir. Through the middle of these heads pass the axes or cross pieces, $j j^1$, which receive the lower ends of the connecting rods, L L^1, resting solely on the axes, $j j^1$.

The guides, H H^1, are of cast iron, and placed in pairs uniformly in the axes of the cylinders, as shown in fig. 1. It should be observed that in one engine it is the under guide, H^1, which receives the principal thrust of the connecting rod, whilst in the other engine it is the upper guide, H. The upper guides carry, in addition to lubricators, the intermediate supports, $l l^1$, of the shafts, $m m^1$, which actuate the slide valves.

The motion of the pistons is transmitted to the main shaft by the wrought-iron connecting rods, L L^1, of rectangular section, and forked at their lower ends to embrace the guides. Each corresponds with its respective piston, which arrangement was necessary, notwithstanding that two pistons of the same pair move at the same time; for the inequalities of the pressure resulting either from the degree of expansion or the motion of the regulator, although the cylinders are proportioned so as to give the same nominal power, would, most probably, if but one connecting rod were employed, increase the wear and tear, and give rise to a serious transverse strain.

The head of each connecting rod is T-shaped, and carries a bearing, and is secured to the T by bolts, which being subjected to considerable strain would, in the ordinary mode of construction, have to be made of large dimensions, but by making these bolts from iron of a specially tenacious nature, the designers have been enabled greatly to diminish the size, whilst still affording the requisite strength both to resist the strain of the thrust and that of the screw threads.

The main shaft, M, which receives its motion from the connecting rods before described, is of wrought iron, and is provided with three cranks. The distance between the bearings being rather great (there being only the bearings on the standards, B), MM. Corbran & Le Marchand have given the shaft a diameter of 7⅛ inches in the centre in order to counteract the strain, whilst the ends outside the engines are reduced to 6½ inches. Each of the large cranks receives a connecting rod of both one of the small and one of the large pistons; the centre crank, which is of half the length of the others, actuates the connecting rod of the air pump. Between the two standards, B, are placed excentrics, N, which actuate the slide valves, whilst the excentrics which work the expansion slides are situate outside. The shaft, M, is supported beyond its cranks by the two pedestals in the large standards, B, and as its journals are provided with shoulders it assists, in conjunction with the two tie rods, C, in maintaining the proper distance between the standards.

When the power has to be given off near the standards, the shaft is cranked beyond, but ordinarily the ends are prolonged to the wall of the engine room, and are supported in two additional pedestals, each bolted to the stone work; toothed wheels gearing with a pinion (as represented in this instance), or two large pulleys, being employed to transmit the motion, and one part of the rim being cast rather thicker in order to balance the weight of the crank. This increase of thickness in the rim on the right-hand side of the wheel, is indicated in the engraving by the dotted circle inside the teeth, the increased thickness gradually diminishing or dying into the reduced thickness on the left-hand side. The whole of the condensing apparatus is situate between the two engines, and is common to both. It consists simply of two cast-iron cylinders, one of which, P, forms the barrel of the air pump, and at the top, the hot water cistern. These two parts are cast together in one piece, with a circular flange strengthened with ribs to rest on the foundation plate, A. The second is the condenser itself, which is connected with, and united to, the air pump by a connected joint; above this a raised flange is formed to receive a film of water, which tends to prevent the admission of air in case the cement should break away.

The condenser is provided with two pipes of similar shape connected with the eduction pipes, R, in communication with the pipes, h, and with the injection cocks, S. The latter are turned from above by means of a spindle, p, passing through the small cast-iron pedestals, b, and terminating in a handle which also serves as an indicator to show the degree of opening of the cocks; although the opening is cylindrical in form, the pressure of the water is sufficiently great to cause the jet to spread through a great part of the eduction tube.

The piston, T, of the air pump is composed of metal segments similar to the steam pistons; its clack, r, is of india-rubber, as well as the upper clack, r^1, which rests on a cast-iron grating, q, secured at the top of the air pump, and through which the piston rod, t, passes; the cheeks, q^1, of the clacks are formed with apertures, through which the water passes more easily and causes the clacks to fall instantaneously, notwithstanding their large size. T^1 is the connecting rod coupled to the central crank which drives the air pump.

The feed pump, V, is capable of furnishing more water than would be required for use in the boilers, if they were intended merely to generate sufficient steam for the supply of the cylinders; but as they may also be required to supply steam for various purposes in the establishments, such as for heating, &c., a movable clack, u, is employed to regulate the suction. The plunger, U, of the feed pump is made to act as a guide for the piston rod, t, of the air pump.

The distribution of the steam to the cylinders is effected by means of the single slide, V, formed with apertures to correspond to each of the cylinders. The steam arrives from the steam jacket as before stated, passes along the pipe, g (fig. 3), through the valve, g^1, the opening of which is regulated by a screw turned by a handwheel, g^2, then traverses a valve, p^1, communicating by means of the levers of a shaft, p^2 (fig. 1), and rods, with the governor (not shown in the engraving), and arrives in the steam chest, whence it passes through the slide, V, to the top or bottom (as the case may be) of the small piston, and then inside the slide to the opposite side of the large piston, whence, after having done its duty, it passes through the slide into the pipe, R, leading to the condenser.

This arrangement has been adopted by MM. Corbran & Le Marchand with a view to prevent the partial condensation of the steam, which usually takes place in passing through the space separating the small from the large cylinder; and the indicator shows that the diminution of pressure is much less than in the ordinary engines.

We are happy to be able to state that the builders have completely surmounted the practical difficulty involved in casting the slide boxes in one piece, as described, viz., adjusting the relative position of the different orifices.

Fig. 4 is a plan of a slide box, looking at the slide face, which rests on the seat prepared for its reception, communicating with the cylinders; and fig. 5 is an under view of the same.

The induction slide admits the steam at the maximum during three-quarters of the stroke of the small piston; and as the proportion between the area of this piston and that of the large one is 1 to 4, it follows that the minimum expansion is 5¼ times the volume introduced; but by means of the system of variable expansion applied to the induction slide, the expansion is carried to the utmost limit practicable, according to the working pressure, say, for instance, in the proportion of 1 to 15, or even 1 to 20, when occasion requires.

The slide has no frame; it is moved by a bar, which crosses it from side to side, and is guided at each side by a stuffing box.

The arrangement of the slide admitting of no direct connection with the main shaft, it was necessary to actuate the former by an intermediate shaft, m (fig. 1), which carries a lever, n, for transmitting motion to the slide by means of the flat double connecting rod, o. On the under side of this shaft are levers to which the excentric rods are jointed. The angle of oscillation of the connecting rods is so slight that it is not necessary to apply guides for the slide rods outside the stuffing boxes.

The variable expansion gear employed is that known as the Meyer system; and the rod of the small expansion slide, v, is actuated in a manner similar to that of the induction slides. As the excentrics, however, are not keyed to the same point, the intermediate shaft, m, is made at both ends in such a way that they enter the one into the other. An indicator placed in the head of the rods of the expansion slides shows the relative position of the two small slides which constitute the slide proper.

The angles formed by the two engines would have admitted of but two excentrics being used, instead of four; but the designers, fearing too great a strain on the same, have deemed it advisable to increase the number. All the joints are, moreover, of tempered steel, which adds to their durability. Notwithstanding these precautions, so great is the pressure on the

large surface of the slides that they would not have been able to resist it, were they not provided with means for compensating or counterbalancing the pressure. This is accomplished by means of a cast-iron ring, X (figs. 1 and 3), inserted in the opening at the top of the valve box. The under part is planed, and slides on a ribbed plate at the back of the slide; the sliding parts project, and extend further than the ring in their alternative motion, so as not to form a shoulder. The pressure of the steam acting on the projecting part of the under flange keeps it firm, whilst the communication with the escape-pipe leading to the condenser secures a constant vacuum in the interior of the ring. In order to prevent the escape of steam either outside or at the top of the ring, the cover rests on a packing, and forms a stuffing box; the difference between the pressure of the external air and the vacuum beneath this cover causing sufficient pressure at the top of the cover to effectually prevent any escape. The four screws are only used to hold the packing; so soon as the engine is put in motion, the plate drops slightly, and becomes detached from the screws.

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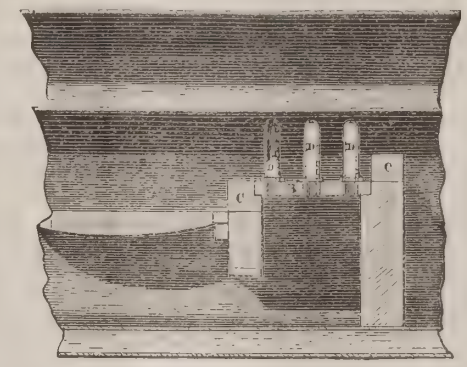
RECENT PATENTS.

FURNACES OR FIREPLACES AND FIREBARS.

JAMES ROBERTSON, *Liverpool.—Patent dated 8th October*, 1866.

THIS invention relates to improvements in furnaces or fireplaces and firebars, and has for its object the consumption of the smoke and gases arising from the fuel, also the protection or preservation of the firebars. In carrying out the invention a plate or slab of fireclay or iron, having perforations through it, is placed at the back of or on the firebars, and resting on firebricks at both ends. This plate extends across the whole width of the furnace, and is open at the bottom, to admit air from the ashpit or from a tube extending from the front of the ashpit to the back of it. A series of tubes of fireclay or iron are made to fit into the perforations in the plate, such tubes being open at the bottom to admit the air passing through the perforated plate. The tops of these tubes extend to, or near to, the bottom of the boiler, they also being provided with small perforations in the sides towards the flue, from the top to the bottom, for the air to pass through them in that direction, so as not to obstruct, but rather to assist or increase the draught. The action of the fire on these tubes heats them to a high degree, and consequently heats the air passing through the small perforations in them, and as none of the smoke or gases can pass away into the flue without coming into contact with the divided currents of highly heated air from the tubes, the consumption of smoke and other inflammable gaseous products of consumption is effected. The action of the cold air inside the tubes preserves them from being burned, and after the smoke or other gases are consumed the hot air from the small perforations will assist in keeping up the steam. When there are many furnaces the whole of the smoke or gases are brought into one flue, and at the most suitable part, before entering the chimney, to cause the smoke or gases to pass through a highly heated furnace, and, when in a highly heated state, to pass between the tubes, and be brought into contact with the heated air issuing from the small perforations therein, whereby the smoke and gases are consumed, and when consumed, the heat from them may be applied to any useful purpose. The firebars are made hollow and open throughout their length and width, and of the form of a wedge, being wide at the top and narrow at the bottom, and made of either cast or malleable iron. Fig. 1 of the annexed engravings represents a part longitudinal vertical section of a portion of a steam-boiler furnace with these improvements attached; and figs. 2 and 3 represent respectively a side and end elevation of the improved compound grate bars for furnaces. A is the furnace, B a plate made of fireclay or metal, and having perforations through it and placed at the back of or on the bars, and resting on fire-brick walls, C, at both ends. It extends across the whole width of the furnace or flue, and is open at the bottom, so as to admit air from the ashpit, or from a tube extending from the front of the ashpit to the back of it: D D are tubes made of iron or fireclay, and fitted into the perforations in the plate, B. These tubes (one of which is shown partly in section) are open at the bottom to admit the air to pass through the perforations in the plate, B, into the tubes, D. The tops of the tubes, D, extend to, or near to, the bottom of the boiler, and are further provided with small perforations of any form in the sides towards the flue, or all around, if required, from

Fig. 1.



top to bottom, for the air to pass through them. The action of the fire on the tubes, D, heats them to a high degree, and consequently heats the air passing through the small perforations in them; and as none of the smoke or gases can pass away into the flue without coming into contact with the small currents of highly heated air from the tubes, D, the consumption or abatement of smoke or other gases then takes place, and the action of the cold air inside the tubes, D, preserves them from being burned; and even after the smoke or other gases are consumed, the hot air from the small perforations will assist in keeping up steam. It is also proposed that where there are many furnaces that all the smoke or gases be brought into one flue; and that at the most suitable part, before entering the chimney, all the smoke or gases shall pass through a highly heated furnace, and when in a highly heated state, shall pass between the tubes, D, and be brought into contact with the heated air issuing from the small perforations in them for their consumption, and when consumed, the heat may be applied to any useful

Fig. 2. Fig. 3.

purpose. It is also proposed that the firebars, figs. 2 and 3, be made hollow and open throughout their entire length and width, and of the form of a wedge, that is to say, wide at the top and narrow at the bottom, and composed either of cast or malleable iron. Wedges made of fireclay or iron, of lengths that in practice may be found to answer best, to fill up all the hollow spaces in the bars, and having grooves in their sides, or perforations made through their centre, to admit air through them from the hollow in the bars, independently of the usual way of admitting the air between the bars. These wedges are made to project above the surface of the bars, so that the fuel will rest upon them and not touch the bars; and when any of the wedges are burned away they can be easily removed and replaced by others, thus protecting the bars from any action of the fire, so that they always remain entire. In some flues or furnaces it may be found necessary to place the tubes, D, horizontally instead of perpendicularly, or they may be placed in any other position that will best suit the form of flue or furnace. In some instances the tubes, D, which may be of any desired form, may be perforated all round.

RAISING AND LOWERING HEAVY BODIES.

J. Henry Johnson, *London and Glasgow.—A communication from* Charles Le Blanc, *Paris.—Patent dated 22nd November*, 1866.

This invention relates to a peculiar construction and arrangement of travelling cranes, and consists in combining together two windlasses in such a manner that they may be coupled or geared together, and operate conjointly, or be disengaged so as to admit of one windlass being operated whilst the other remains stationary. The barrels or drums of these windlasses may be adapted for the use of ropes or ordinary chains, or flat linked chains; in the case of using chains the ordinary provision should be made for causing the chain to gear or engage with the winding pulley, drum, or barrel. Each barrel carries a spur wheel, but one of these wheels is caused to slide along its axis by the aid of a clutch lever, so as to enable it to be thrown in or out of gear with the spur wheel fast on the second barrel. A ratchet and detent arrangement should also be applied to each barrel in order to retain them fixed or stationary when required. When ropes are employed, each barrel winds and unwinds a separate rope of its own; but as the barrels are of equal diameter, it follows, that when geared together (the ropes being coiled round both in the same direction) that one rope will be unwound just in proportion as the other is wound. One of these ropes passes over an overhead guide pulley on the end of the travelling rails of the crane, which are supported by uprights at each end. It thence passes longitudinally between the rails and over a pulley in a travelling block or carriage, and its pendent end may either be attached directly to the weight, or the rope may be passed under a snatch block and returned to the carriage again, to the frame of which it is secured. The other rope from the second windlass also passes over a guide pulley at the end of the travelling rail, and thence proceeds longitudinally above such rails to a guide pulley on the opposite end thereof, and back to the carriage to which it is secured. When it is required simply to raise or lower a weight without traversing or moving it horizontally, then the last-mentioned windlass is held fast, and the spur wheel on the other is slid out of gear with its neighbour, and the second windlass rotated in the required direction, according as the weight is to be raised or lowered, using for that purpose an ordinary winch handle, or steam or other power. When the weight has been sufficiently elevated it may be transported or moved horizontally by gearing together or coupling both the windlasses, when, as the one gives out just as much rope as the other takes up, the carriage will be caused to travel in either direction along the rails. One important advantage secured by this invention is, that the travelling rails need not necessarily be either perfectly rectilinear or level, which, in cases of very uneven ground, and where portable cranes are used, is a great desideratum. By using a chain and chain pulley in lieu of a smooth drum or barrel, a less length of chain will be required, as in that case the two chains may form one, which will be actuated by both windlasses without influencing the amount of slack chain which should hang between the two chain pulleys, the one taking up no more chain than is given off by the other.

Fig. 1.

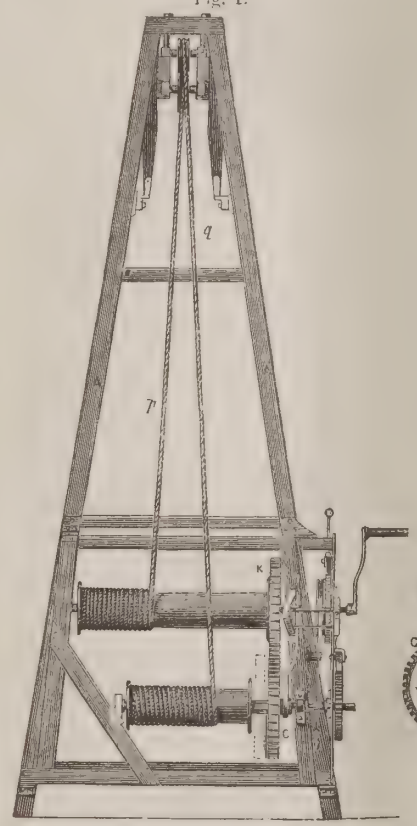


Fig. 2.

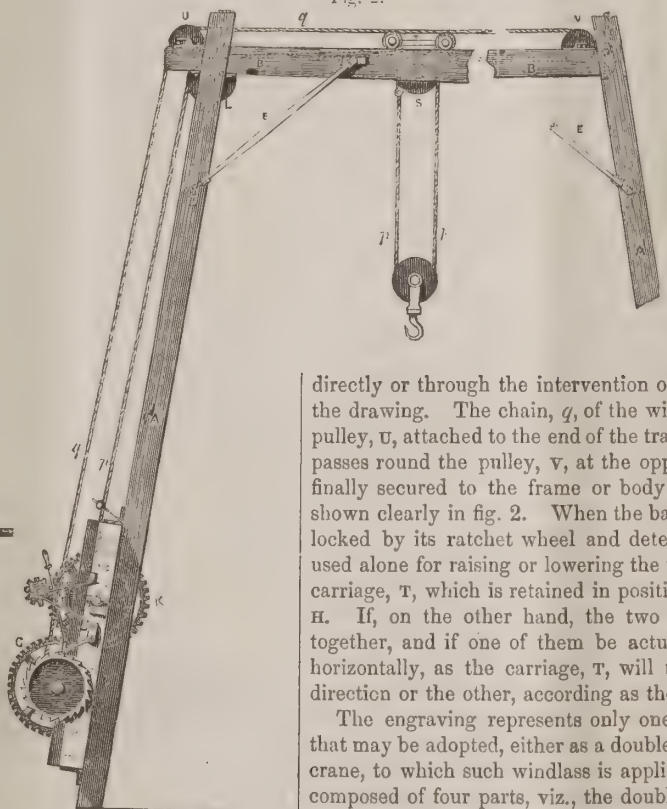


Fig. 1 of the accompanying engravings represents an end elevation of the improved crane. Fig. 2 is a corresponding side elevation of the same. C is the principal windlass barrel, and H the auxiliary windlass barrel. So long as the two windlasses are not geared together either of them may be worked independently. The shaft of the barrel, C, has a spur wheel, K, keyed thereon; whilst the shaft of the other barrel, H, carries a similar spur wheel, G, also keyed thereon, but capable of sliding along the shaft, so as to be brought into gear and thrown out of gear with the spur wheel, K, on the main barrel, C. Each barrel, moreover, may be provided with a ratchet wheel and detent, and with an ordinary or other break. The chain, *p*, of the main barrel, C, passes over a guide pulley, L, fixed to the end of the tramway, B, of the traversing carriage, T, nearest to the windlasses; it thence passes over the pulley, S, fixed to the carriage, T, and is finally attached to the load or weight either directly or through the intervention of a block and pulley, as shown in the drawing. The chain, *q*, of the windlass, H, also passes over a guide pulley, U, attached to the end of the tramway next the windlasses, thence passes round the pulley, V, at the opposite end of the tramway, and is finally secured to the frame or body of the traversing carriage, T, as shown clearly in fig. 2. When the barrel, H, is thrown out of gear, and locked by its ratchet wheel and detent, the main windlass, C, may be used alone for raising or lowering the weight, without any motion of the carriage, T, which is retained in position by the chain, *q*, of the barrel, H. If, on the other hand, the two windlasses, C and H, be geared together, and if one of them be actuated, the weight will be moved horizontally, as the carriage, T, will travel along the tramway in one direction or the other, according as the barrel C or H is actuated.

The engraving represents only one of the numerous arrangements that may be adopted, either as a double-geared windlass or as a traveller crane, to which such windlass is applied. The crane is portable and composed of four parts, viz., the double windlass, the two standards or uprights, A A′, the cross beam, and tramway, B. The cross beam is screwed to the uprights, A A′, and the windlass, C, to one of such uprights, A, and the angles between the uprights and the cross beam are fixed by the corner braces or stays, E, of variable length.

SAFETY LAMPS.

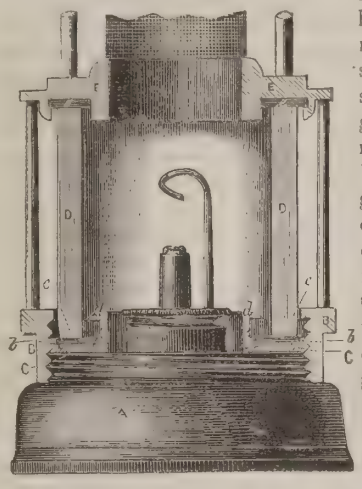
Evan Thomas, *Aberdare.—Patent dated 20th November*, 1866.

This invention has for its object the rendering the ordinary miner's safety lamps more secure by the adoption of arrangements which prevent the glasses from becoming loose, and so preventing the entry of the foul gases into the lamps.

According to the present ordinary construction of miners' safety lamps, the glass is held in the lamp by means of a plain or flat metal ring, which fits into a screw on the lower part of the frame of the lamp, and bears directly against the bottom of the glass, no allowance being made for expansion of the glass, and hence the frequent fracture of lamp glasses. As it frequently happens, moreover, that the glass and ring do not fit together accurately, an inlet of foul air often takes place at that part. The ring is constantly liable to become unscrewed by simply turning the glass from the outside, the friction of the glass against the ring carrying it round with it. Now, according to this

invention, an annular groove is formed on the surface of the ring, and causes the glass to fit into such annular groove; and in order to prevent the possibility of the ingress of foul air into the lamp at the top and bottom of the glass, and to allow for expansion, an elastic packing ring or washer of vulcanized india rubber is introduced at those parts, and at the bottom of the glass is interposed a loose metal ring or washer between the india rubber and the annular grooved ring. By this means the loosening of the securing ring by turning the glass is prevented.

The accompanying engraving represents a partial sectional elevation of an ordinary miner's safety lamp, with the improvements adapted thereto. A is the base of the lamp, which is screwed into the rim or lower frame, B; but before screwing on the base, there is screwed into the rim the annular grooved securing ring, C, such ring being screwed home till it bears against the bottom of the glass. The annular groove or channel, *a*, formed on the surface of the securing ring, C, contains first a metal washer, *b*, and above that again the elastic or vulcanized india-rubber packing ring, *c*, upon which the bottom of the glass, D, directly bears. Both the rings being loose or free to revolve on the surface of the securing ring, C, the turning of the glass cannot effect the loosening of the securing ring. The metal washer, *b*, is kept in the groove by the shoulder, *d*, screwed into the centre of the grooved securing ring, C, or by any other convenient contrivance. The upper frame or rim, E, of the lamp is annularly grooved on its under surface to correspond with the annular groove in the securing ring, C, and it is also provided with an elastic packing ring, *e*, similar to the packing ring, *c*, below; so that the upper as well as the lower ends of the glass bear directly upon the elastic packing, in lieu of upon the metal itself of the lamp.



LAW REPORTS.

THE FLOUR GRINDING PATENT.—BOVILL *v.* CRATE.—Before Vice-Chancellor Sir W. P. Wood—29th April, and thirteen days in Easter and Trinity Terms.—This was the hearing of a cause in which Mr. George Hinton Bovill is plaintiff, and Mr. Augustus Crate, a miller at Winchester, and a member of the Millers' Association at Manchester, is defendant; and in which the plaintiff sought an injunction to restrain the use by the defendant of the plaintiff's invention of "Improvements in the manufacturing of wheat and other grain into flour," with the usual account and damages. The patent is dated 5th June, 1849, and having been amended by disclaimer on the 1st of May, 1855, was prolonged for a period of five years by the judicial committee of the Privy Council in 1863.

The invention, as described in the claims to the specification, was stated to be—"Firstly, fixing the top stone and causing currents of air, either by exhaustion or pressure, to pass between the grinding surfaces of millstones when the top stone is so fixed, and in the introduction of ventilating pipes in the stones. Secondly, exhausting the dusty air when the same has been blown through the grinding surfaces of the millstones from the stone cases or chambers receiving the meal. And lastly, the passing of the dust or stive, caused in the process of grinding, through suitable porous fabrics, by which the flour is filtered from the air."

The defendant was charged with infringing the patent by using the invention described in the second and third of these claims.

The material parts of the specification, as amended by the disclaimer, were as follows:—"In carrying out the second part of my invention, when working millstones with a blast of air, I introduce a pipe to the millstone case, from a fan or other exhausting machine, so as to carry off all the warm dusty air blown through between the stones to a chamber, as hereinafter described, by which the dust in the mill is avoided, and grinding improved. And this part of my invention relates only to sucking away the plenum of dusty air forced through the stones, and not to employing a sufficient exhausting power to induce a current of air between the stones, this having before been practised, as above mentioned. The third part of my invention consists in straining the stive or air, which is surcharged with fine flour, through suitable porous fabrics, which retain the flour and allow the air to pass through; and this I accomplish by exhausting the air from the millstone case or other cloud chamber, receiving the meal from the stones by means of a fan or other exhausting machinery, and blow the stive so exhausted into a chamber, having its sides and top formed of one or more thicknesses of suitable porous fabrics, to allow the air under pressure to pass out deprived of the flour by means of this filtration. I also obtain the same result by placing the filtering chamber between the stone case or chamber receiving the meal and dust from the stones and the exhausting machine. The stive or dusty air is then sucked through the filtering fabrics, instead of being blown through, and the air passes away clean as before."

The patent has been the subject of an enormous amount of litigation, the plaintiff alleging that he had established the validity of his patent in several previous suits; and that on the occasion of the application for a prolongation of the patent he was opposed by a combination of millers, who urged every possible objection to its validity. The defendant alleged, on the contrary, that in the greater part of the previous litigation the defendants had either submitted to an injunction, or the suits had been compromised, and that the validity of the patent had in fact been only thoroughly contested in two suits, one being an action of *Bovill* v. *Keyworth*, in the Court of Queen's Bench in 1857, and the other a suit of *Bovill* v. *Goodier* (in which latter suit proceedings are still pending), and that the judicial committee of the Privy Council, on the occasion of the application for prolongation, declined to go into the question of the validity of the patent.

Mr. Grove, Q.C., Mr. Druce, Q.C., Mr. Theodore Aston, Mr. J. C. Matthew, and Mr. Frederick Harrison (instructed by Messrs. Harrison, Beal, & Harrison), appeared for the plaintiff. Sir Roundell Palmer, Q.C., Mr. Edward James, Q.C., Mr. Little, Q.C., Mr. Watkin Williams, and Mr. Lawson (instructed by Messrs. Reed, Phelps, & Sidgwick), appeared for the defendant.

The evidence in chief was given by affidavit, but the cross-examination of such of the witnesses as were cross-examined took place in open court. The plaintiff's case, as stated by his counsel, and as set out in the pleadings of the suit, was that previously to 1843, in the ordinary process of grinding corn, it was found that millstones often got clammed up by the heat produced in grinding, more particularly when the wheat was not very dry, whereby the meal was much injured. The power required to drive the stones was greatly increased by this pasting or clamming, and a great deal of dust was produced in the mill from the old system of grinding, which seriously affected the health of the workmen. The plaintiff's invention was directed to getting rid of the inconveniences above mentioned. Inventions for the same object had been comprised in patents granted to Gordon in 1844, to Newton in 1846, and to the plaintiff in 1846; but these were all insufficient, and the plaintiff alleged that it was not until his patent of 1849, the one now in question, that any effectual method of obviating the defects above stated was known.

Newton's method was a vacuum exhaust, in which an open meal spout could not be used, and in consequence the ground grain was drawn with the air through the air-pump, and blown or pumped out mixed with a great volume of dust, occasioning excessive dust and waste in the mill. Gordon's plan was a blast upwards through the eye of the millstones. This also failed, because the current, instead of passing between the grinding surfaces of the stones, took the readiest means of egress, and escaped out of the eye of the millstones, which were left open.

The plaintiff's patent of 1846, which was stated to have been founded on an invention by M. Bougleaux, of Leghorn, a half-share of which had been purchased by the plaintiff for £10,000, was intended to increase the grinding power of the stones by raising powerful currents of air between the stones, from the centre to the periphery, by a vacuum exhaust, or by closing the eye, and blowing an artificial blast into the closed eye. But this invention, it was found, did not get rid of the previous inconveniences of the warm air being mixed with the meal, and passing down the meal spout with it.

By the plaintiff's invention of 1849 these defects were got rid of. This was effected by sucking away by an ordinary exhausting fan the plenum or excess of dusty air in the millstone cases, and not by employing a sufficient exhausting power to induce a current of air between the millstones without a blast. This sufficed to carry off all the warm dusty air to a chamber, by which the dust and waste was avoided, and the manufacture greatly improved. During the process the meal passed down the open meal spout in the usual way; but by exhausting the plenum, the warm clammy air was drawn away from the meal, leaving it cool, dry, and fresh, as it issued from the meal spout, and no stive or dust escaped into the mill.

The plaintiff's invention had been adopted by government, after a series of experiments at Deptford Victualling Yard; and all corn ground by the government is, it was stated, manufactured according to the plaintiff's patent process.

The plaintiff charged the defendant with infringing his patent by the use of an exhaust for carrying off the dusty air, and also by using a stive room or porous chamber similar to that described in his specification; and alleged that although the defendant did not apply an artificial or superadded blast, still he infringed the plaintiff's patent, inasmuch as the natural action of the millstones, when in motion, was that of a fan-blowing machine; and that the specification covered, not merely the use of an exhaust in combination with an artificial blast, but an exhaust of the plenum, used with no other blast than that produced by the stones themselves.

The plaintiff relied on the previous litigation as having established the validity of his patent, more particularly on the cases of *Bovill* v. *Keyworth* and *Bovill* v. *Goodier*. The latter was a suit in the Court of the Master of the Rolls, seeking an injunction against infringement, in which his lordship had pronounced an opinion in favour of the construction of the specification contended for by the plaintiff, and granted an injunction against the defendant (whose apparatus was not the same as that of the defendant in this suit), at the same time, however, directing issues as to novelty to be tried at common law. The trial was had before Mr. Justice Willes, in December, 1866, and occupied some days; and the judge, in charging the jury, expressed a view coinciding with that of the Master of the Rolls on the construction of the specification. The jury, however, found a verdict for the defendant on the issue as to novelty. (See *Prac. Mech. Jour.*, vol. ii., New Series, page 309.) A new trial was subsequently moved for before the Master of the Rolls, and a certificate of Mr. Justice Willes to the effect that he had expected a different result having been read, an order for the new trial was made. This trial, however, has not yet been had.

The defendant's case was that he did not use an artificial blast in his mill, and that therefore he did not infringe the patent; the true construction of the specification being, as he contended, that the exhaust of the plenum was only claimed when used in combination with an artificial blast, and did not extend to forbid the use of an exhaust with no other blast than the natural blast (if any) of the millstones.

The defendant, however, denied the existence of the natural blast as a fact, and produced evidence to contradict the plaintiff's view of the millstones forming a

fan-blowing machine. The defendant also denied that he used a porous stive room, and submitted that his apparatus was in other respects different from that described by the plaintiff. He also contended that the specification was bad, because in the description of the third part of the invention the porous stive room was only directed to be made of "suitable" porous fabrics, without giving any criterion of suitability, whereas it was proved that the plaintiff had made many experiments to ascertain, and had ascertained, what was the best fabric to use. The defendant therefore insisted that the plaintiff had not put the public in possession of all his knowledge on the subject, and that the patent was therefore void. On the question of the novelty of the invention, the defendant produced evidence of the prior user of apparatus, which, as alleged, substantially anticipated the plaintiff's present claim to a regulated or modified exhaust, without the superadded blast, at the following places:—Mr. Kidd's mill, at Isleworth; Mr. Potto Brown's mill, at Houghton; and also at Tradeston mills, Glasgow; Drypool mills, Hull; Denton mills, Carlisle; Mr. Fison's mill, at Ipswich; Tide mills, Deptford; and Messrs. Westrup's mill, Shadwell. He also produced evidence to show the use prior to plaintiff's invention of porous fabric stive rooms at Newark and Chester, and that a process similar in principle to that employed by plaintiff for straining the stive had been patented by one Jones in 1846, in an apparatus relating to the sifting of charcoal.

The defendant also alleged that the plaintiff's invention was described in patents granted in France, viz., in a patent granted to Vallod in 1836, to Cartier in 1843, and to Damy in 1846, all of which were described in publications deposited in the British Museum before the date of plaintiff's patent. He also relied on a patent granted in France to Cabanes in 1845, which had expired in 1860. The defendant insisted that the invention described in this patent was substantially an anticipation of plaintiff's invention, and that as the foreign patent expired in 1860, the subsequent grant to the plaintiff of new letters patent in 1863 was void, under the 25th section of the Patent Law Amendment Act, 1852, which provides that letters patent granted here for inventions previously patented abroad shall not continue in force after the expiration of the foreign patents. He also insisted on certain parts of the plaintiff's Scotch patent, and his English patent of 1846, as being anticipations of his present patent of 1849. With regard to the prior litigation, the defendant insisted that *Bovill* v. *Keyworth* proceeded on a different view of the specification to that now set up by the plaintiff, and did not decide the point now raised, viz., that the claim did not extend to an exhaust without the superadded blast; the infringement in that case having been a combination of an artificial blast with an exhaust, and there therefore having been no need to raise the present question. The defendant also insisted that the Master of the Rolls in *Bovill* v. *Goodier* had proceeded on an erroneous view of the effect of *Bovill* v. *Keyworth*, and that on the trial of the issues in that cause the question had not been argued before Mr. Justice Willes, and that that learned judge had been fettered by the previous judgment of the Master of the Rolls.

June 14th.—The Vice-Chancellor now delivered an elaborate judgment; and having stated that he considered the judgment of *Bovill* v. *Keyworth* was of great importance in the case, said that it did not seem to have been disputed whether or not, in the ordinary process of grinding flour, an inconvenience was produced by reason of a blast being created when an artificial blast was used, but merely whether a blast created simply by the rotatory motion of the stones, occasioned an inconvenience which was intended to be met by Mr. Bovill's patent. His Honour then examined the evidence at length on this point, and stated his reasons for coming to the conclusion that there was, in fact, a blast of air caused by the action of the stones, and that the existence of this was known to the plaintiff and millers in general at the date of the plaintiff's patent. With regard to the second part of the invention, which was the important part to be determined, his honour read the paragraphs of the specification as above set out, and added that it could not be said that the plaintiff described any invention until the sentence beginning "And this part of my invention relates only to sucking away the plenum of dusty air." It had been argued that the context shows that by the word "blast" in the specification the plaintiff meant only an artificial blast, and that this was further proved by looking to the disclaimed part of the specification, where, in a passage struck out by the disclaimer, the plaintiff had spoken of "stones worked by a current of air obtained by a blast or exhaustion, or when worked without wind in the ordinary manner." It was said here, and no doubt with great force, that the plaintiff had thereby distinguished three classes of things, and had distinguished the ordinary working without wind from the mode of working with the blast. It was therefore argued that the plaintiff had claimed for nothing except in the case of there being an artificial blast of air. But his Honour thought (and he assumed on the evidence that the patentee knew that there was a blast when working in the ordinary manner) that the plaintiff by his specification merely described one particular mode of working, viz., with an artificial blast, and that the use of the words above quoted ("this part of my invention relates only," &c.) showed that the actual invention consisted in just having the moderate amount of exhaust which would not draw through, and that the plaintiff claimed generally the sucking away the plenum of dusty air. His Honour then examined the judgment of the Court of Queen's Bench in *Bovill* v. *Keyworth*, and came to the conclusion that this point was decided in that case. With regard to the fact that the invention was invaluable, his Honour thought that nothing more was wanting than this—that after the invention, previously to which every one was setting to work to prevent the evil of dust and stive, the flood of patents which had been poured on the public in France and England had been suddenly stayed, and this appeared to have been because the right thing had been hit upon. As to the point which had been raised upon the Scotch patent of the plaintiff, viz., that the inventory described in the specification of 1849, of certain apparatus for introducing air between the millstones, had been anticipated by the Scotch patent, his Honour thought that the principle applied by the House of Lords in the case of *Betts* v. *Menzies* applied, and that as there was no evidence that any workman had made the invention described in the second patent from the description in the first, he did not think that the latter was any anticipation of the invention.

As to the objection to the third part of the invention, his Honour thought the patent was not for a process for finding suitable fabrics for straining stive and air, but was a patent for a process by which the stive could be saved on its way by the contrivance of a chamber into which it was blown, and that there was no need for the patentee to tell the best mode of sifting it. Upon the question of novelty, his Honour had dispensed with a reply upon all the cases except those of Isleworth and Houghton, because it appeared to him that those were the only two cases in which it could be brought in question. The learned judge then examined these two cases at great length, and came to the conclusion that they did not show an anticipation of the plaintiff's patent. With regard to the Drypool mills, his Honour, on review of all the evidence, did not give any credit to the defendant's evidence as to this mill, and the other cases appeared to be quite distinguishable in several respects from what was claimed by the plaintiff. As to Jones' charcoal patent, the process described seemed to have no analogy to the straining process described by the plaintiff.

His Honour then adverted to the foreign patents, and said they all came within the principle laid down by the House of Lords in *Betts* v. *Menzies*. It was not enough to throw before the court a large bundle of foreign patents and say, we will show you this or that is the identical thing described. What the court wants to know is, whether the thing described in those patents would work. No evidence had been produced as to these foreign patents having been worked, and none of them had been used in England. As to Cabanes' patent, to bring the matter within the principle of the above-mentioned section of the Patent Law Amendment Act, it should have been shown that this was identical with plaintiff's invention. And here again the question is, Was the thing worked, or ought there not to have been evidence either of English or French workmen to say that they believed the thing workable? Those patents were in the same position as Dobbs' patent in Betts' case: there was a specification which seemed to anticipate the thing in question, but nobody could be found to say that ordinary workmen could work with those means. On these grounds his Honour had not heard a reply as to these French patents.

His Honour then at length discussed the question of infringement, and came to the conclusion that the apparatus of the defendant was an infringement of the plaintiff's patent, and made a decree for an injunction, with an account of all corn ground by the machinery of the defendant's erected on the plaintiff's principle, and an inquiry as to the consequent damages sustained by the plaintiff. The defendant must pay the costs of the suit, and the certificate of Lord Campbell that the validity of the patent was in question in *Bovill* v. *Keyworth* having been handed in, his Honour said that the costs must be taxed as between solicitor and client.

REVIEWS OF NEW BOOKS.

THE MECHANICIAN AND CONSTRUCTOR FOR ENGINEERS; comprising Forging, Planing, Lining, Slotting, Shaping, Turning, Screw-cutting, &c. By CAMERON KNIGHT. 4to, with lithographs. To be completed in twenty-four parts. Spon: London. Parts I. to V. 1867.

THE French were greatly in advance of us, in time, in compiling accurate and well illustrated descriptions of all their leading trades and industries. No more perfect models for such descriptions have ever been produced than those of the *Arts et Métiers* of France, given in the great folio edition of the Encyclopédie of D'Alembert and Diderot, published nearly 100 years ago. At the present hour they are equally before us, in the style in which they describe and illustrate such great industries of our own epoch as they deem worthy of description in the elaborate manner which is at once scientific and technically practical.

We have in English few such works, almost none in recent days. In so far, therefore, this production of Mr. Cameron Knight comes upon a nearly unoccupied field and deserves a fair reception. The subjects of which he proposes to treat are of high technical value in themselves; and there is no question but that much valuable information, and of a practically useful and available sort, might be conveyed by text and plates to our working mechanics of the better order, and something gained by the youngster who is to be at a future day the mechanic, if he would only study these.

We do not wish to pass anything like a harsh criticism upon the actual performance, so far as it has yet gone, of Mr. Knight; but we cannot avoid admitting, as our courteous friends in France would say, that "in its excellencies we admit ourselves to find much still to be desired." There is a vast deal of *real* knowledge, such knowledge as no man can have who has not gathered it in the workshop; but it is knowledge often not quite well digested, nor put into order, and never looked at from a sufficiently lofty stand-point of *scientific* information as to the *principles* which guide the operations described, to render the information given capable of being more than empiric, that should render it predictive and fructificatory in the mind of the man who has read it. To illustrate what we mean in a humble but pertinent way:—We all know what a cookery book is, a disjointed string of recipes, one after another, each accurate enough that the reader having caught the hare may cook it, but without a reason or a guiding thought or principle throughout. The book will tell you how to salt meat and to pot herrings, and so forth, but you can gather no principle common to both these, and to a score other processes described for the preservation of meat. You can neither know why meat won't think proper, like all proper

portions of society, to keep itself, nor inform you why it is that, like certain improper portions of society, it undergoes a certain process and then it can "be kept." Do this and the meat will be good, but why, not a word; or should we fail in following the recipe, of explanation on any known principle, nothing.

Now these five parts all relate to the cookery of forged iron. We have plenty of recipes, some good; a few, we feel bound to say, very bad; now-a-days, many only of use to the tyro, who can gather them up in his first week in the smithy: but little or no principles of any sort. Now that is not the way that books on practical working of any sort, or trade, or craft, ought to be written. A book "On the Practice of the Professor of Saddlery and Harness-making, comprising the Use of the Awl, and the Recent Improvements in the Application of the Giant Sewing Machine to Pig Skin," should not be content with inspiring the student of that useful calling with the after-life conviction that there is nothing like leather, and telling him the many ends, as well as waxed ones, to which it may be applied, but should begin by making him clear and sure about *what leather is;* what different sorts of it there are, all coming from one common substrata of material; what are their several properties, chemical, physical, and mechanical; and how he may know when leather is good and when bad. If such shall have been taught with a respectable amount of *true* knowledge, the saddler himself, or even a man not a saddler, who has never drawn a stitch in his life, will find himself in possession of some information that will enable him to dispense with a whole volume of recipes about the ways he should or should not employ or apply his leather and his work upon it in practice. So by forging of iron, first let the smith grasp thoroughly the nature of the material he is going to deal with, then that of his appliances and tools, all in their broadest generalities—the recipes become of minor importance. Without such preliminary knowledge the recipes alone are but blind guides.

Forging, according to our notions, ought to be treated now-a-days under three great separate heads at least, each of these separable again, viz., steam-hammer work; pressure-forging by power, and all power-moulded work; hand forging, heavy and light, and the use and abuse in this of all hand tools and methods. But before any one of these were treated of, or even touched upon, the work should teach the properties of iron, upon which the varied operations of forging depend, and the nature and laws of plastic bodies amongst which in all states, but especially while hot, it is found, and upon which all forging depends. In fact, a treatise on forging should begin by a rapid and clear *resumé* of M. Tresca's researches on the "Flow of Solids," of which translations have appeared in part in these pages from time to time, and with the statement of much else besides, the whole of which together go to make up the science proper of the blacksmith.

Such science, truly conveyed by a competent man, is the only real road and short one to practical skill and excellence. It is something totally different from the barren sort of smattering which is less honest and real than even the "recipe book," and which was so justly ridiculed in the old song of Dr. Birkbeck's and Mechanics' Institute days, in which the advantages of both those great but bye-gone institutions to the blacksmith were recognized by admitting the great fact that

> "He knew that his iron was hot,
> Because it was full of caloric."

It is just that true science, within and in reference to a well defined narrow circle, that is conveyed to the workman in France in its magnificent establishments for technical education, but which is not to be had amongst us in Great Britain, and to supply which in a groping and purblind way was the intention, or one of them rather, of the old advocates of Mechanics' Institutions of thirty-five years ago. Now we observe with regret, that to supply in his opening chapters any knowledge of this sort Mr. Knight does not attempt; possibly he is wisely conscious that he has not got it to supply of the quality that alone would be of any use. Nor has his mixing up power and hand forging continually, as we think, added clearness to his work.

We miss also amongst the recipe-book parts of the work, some notions which, under the opprobrious name of "dodges," we ourselves learned in our hot youth in days gone by from one John Bailley, an old Liverpool blacksmith, well known to the late Francis (and alas! that we must add Edward also) Humphreys, a workman the best for heavy work that we ever saw swing sledge. "Scarphs" are nice and kittle things to make well for shutting heavy work, say to weld up a broken 7-inch piston rod. Bailley made a very peculiar one and the best we ever saw. Mr. Knight seems unacquainted with it. His book is, or rather will be. not a bad one, but it might be much better.—Ed.

A History of the Machine-wrought Hosiery and Lace Manufactures. By William Felkin, F.L.S., F.S.S. London. 1 vol. 8vo. Pp. 559. Longmans, Green, & Co. 1867.

Mr. W. Felkin's volume supplies a want which has long been felt by those who are either directly or indirectly interested in the highly important branches of industry here treated of. The author's object, most ably carried out, has been, in the words of his introduction, "not only to gratify a desirable curiosity as to the scientific world around, but also to show how, by the activity and ingenuity of individuals, science has been made contributive to highly important results, and thereby to furnish a wholesome stimulus to endeavours to benefit mankind." The subject is divided into thirty-two chapters, commencing with the early origin of the hand-loom, which is known to have existed at a period soon after the Flood, the sacred books of Hindustan showing that the weaving of cotton goods was practised in that country from nearly the time of the universal deluge; indeed, the absolute origin of the hand-loom is lost in the impenetrable mists of time. The early and doubtful origin of hand-knitting, and the invention of the stocking-loom, with the doubts that have been entertained as to the real inventor, are next touched upon. The author traces and describes, in a clear and precise manner, the various important improvements which have been introduced into hosiery and lace machines down to the present time, giving a short biography of the more eminent improvers, and a separate view of what each inventor accomplished. By this mode of treating the subject, in contradistinction to a purely chronological account, an approach to classification is obtained which possesses many obvious advantages. The work contains some admirably executed facsimile representations of lace and bobbin net, showing the peculiar characteristic of each variety of manufacture; but we cannot extend the same approval to the illustrations of a purely mechanical nature. In most of the examples before us we notice a lack of that detail and distinctness which are requisite to the thorough comprehension of the intricacies of warp and lace machinery.

Mr. Felkin's name has been long associated with the town and trade of Nottingham; and it must be gratifying to his townsmen to find that his labours in this work are appreciated, not only in this country, but on the Continent and in the United States, as is proved by the long list of subscribers appended to this volume.

The Sewage Question: a general review of all systems, &c., and a description of Captain Liernur's system, &c. By Fred. Chas. Krepp, Mem. Ins. C.E. of the Netherlands. 1 vol., large 8vo. Longmans & Co. 1867.

This work, though liable to be called by some persons by some hard name, as a mere leading up to the interested recommendation of one particular scheme in which the author announces himself as professionally interested, is, notwithstanding, a very useful and meritorious literary production, and a work that ought to be on the shelves of every engineer engaged in sanitary undertakings. It is an exhaustive sort of work in its way, for it comprises the very best and most complete condensed analysis and summary of almost all that has been said or done as respects sewage up to a very recent date. This is connected by a good deal of critical commentary, which generally proves the writer to be well acquainted with the principles and practice of the complicated engineering problem (sewage) with which he is engaged; and as to the objections raised to divers proposed "systems," &c., shows candour, and generally good sense.

Unfortunately, all who know anything thoroughly about sewage questions are but too well convinced of the difficulties which beset it on all sides, and see the nature of these difficulties far more distinctly than they can discern any way out of them. However, Mr. Krepp is not quite of that opinion. He unhesitatingly endorses the pneumatic system of Captain Liernur, as not only the best that has been divulged, but as being, in fact, perfect, and leaving nothing to be desired in its solution of the great problem of how excrementitious matter can be collected and removed from great cities in ways consistent with health, decency,

comfort, and modern civilization, and yet the matter devoted, with its full value undiluted and undiminished, for the enrichment of the soil.

The Liernur method has been already described in several English journals, so that we shall not in a mere review dilate largely upon its details. Confessedly merely a new combination of well-known parts or methods, it professes to be greatly in advance of those "systems," such as that in use in parts of Paris, which it most resembles, but from which it certainly differs in some very material respects. Generally, the Liernur system consists in forming a system of privies in each dwelling, emptying into a small air-tight reservoir. This is by iron pipes in communication with another and larger reservoir under the street, which is common (as a reservoir) to several adjacent dwellings. An air-tight valve, comeatable from the street, shuts off or opens the communication at will between each privy reservoir and that under the street. A locomotive engine, working air pumps and drawing with it iron air-tight movable reservoirs on wheels, comes at intervals to the street reservoirs. By suitable apparatus, connection is established between the air pumps and exhausted movable reservoirs and the street reservoir below. The vacuum being formed, the valves at the different houses are in succession opened, and by the construction of the house reservoirs and tubes connecting those with the street reservoir, the excrements of each privy are in succession drawn or sucked into the latter and thence into the movable exhausted reservoir, which, when full, becomes the vehicle of transport. Other details are given for the removal and employment on the land, &c., but the above is the general outline. That there is a large element of practicability in the system we do not think any practical engineer will deny; but we confess ourselves amongst those who could only pronounce it an experiment well worthy of being tried upon a large and perfect scale, and persevering attempts made to remove the difficulties that we doubt not would soon be encountered in its use. We shall not venture to discuss these here; a review would no longer be one were we to attempt it; but we may just say this much, all plumbers and architects or builders who have had any large experience of water-closet work, in even our most enlightened towns and cities, know full well that the perpetual derangements to which these, upon all their various constructions, are proved liable, arise not from defects in principles, nor yet often from defective construction in details, but simply from utter carelessness on the part of the users, or from beastly habits and neglect on the part of servants, &c. A closet is found "stopped," the "house is poisoned," and so forth, and the plumber is sent for and probably meekly receives a jobation in the library from *pater familias* for the badness of his work.—"Why, Mr. Tinker, it is not three months since I paid your bill for this same closet being out of order before," &c. The plumber opens the trap, or has perhaps even to rip up part of the lead soil pipe, and he finds out that the obstruction is that the housemaid has dropped her brush into the closet and could not pick it out, and so discreetly said nothing about it; or that my lady's maid has disposed of an empty Eau de Cologne bottle by popping it down the closet, with an implicit conviction that closets are meant to swallow everything; or there have been tradesmen in the house while the family was "at the sea side" and the painters disposed of the room paper taken off the bedroom walls and their waste "size" in the same way; or the carpenters have been using the closet and thought it tradesmanlike to employ a good wangle of shavings in lieu of paper. In a word, the closet is put out of order by no fault of its own in theory or practice, but by the malpractices of the users.

Now, we do not see what is to prevent precisely these same evils besetting the Liernur system, and if so, with far more formidable results to the peace and nostrils of the inmates of the pneumatically-drained, or then not drained at all, houses. A good vacuum may suck readily enough a thick mud of fæces and urine through many yards of pipe, but brushes or smelling bottles, or nebulous bundles of shavings so enveloped, *jamais*.

Well, were we to go—as we have said we will not here do—more into the matter, we could start a good many other like and unlike, but all real and practical difficulties. But the same may be done more or less with every project not yet fully proved, and having a good many contingent conditions to grope or grapple with. We should like, therefore, to see Liernur's system fairly, fully, and largely tried, and by those who would not declare against it at the first whiff of failure or difficulty.

As to Mr. Krepp's book itself, we need not say anything more than that it is published by Longmans, and in their usual style.—Ed.

FOREIGN LITERATURE.

Dictionnaire pour la Correspondance Télégraphique Secrète, Précédé d'Instructions Detaillées, et Suivi de la Convention Télégraphique Internationale conclue à Paris le 17 Mai, 1865. Par un Secrétaire de Légation. 1 small vol. Berger Levrault et Fils, Paris and Strasbourg. 1867.

This is an absolutely special technical handbook for the electro-telegraphist engaged in the transmission of secret despatches upon Continental lines upon the system of cypher agreed upon by the Convention above mentioned. The system is based upon the substitution of numbers for words, of which there is a considerable dictionary given, along with certain brief and clear rules (some of which show much ingenuity) for the necessary grammatical inflections, and for various conventional methods of expressing certain things, and for abbreviating, &c. The work is so far rather of Continental than of British interest, though it is hard to see why it should not be in use in our British telegraph offices in connection with the Continent.—Ed.

Les Houillères de la France en 1866. Par Amédée Burat, Ingénieur, &c., Secrétaire du Comité des Houilléres Françaises. 1 vol. 8vo, with Atlas of Plates. Baudry, Paris. 1867.

Those who know the author by the reputation of some of his previous works, such as his "Minéralogie Appliqué" and his greater work, the "Matériel des Houillères," need not be assured that the present is worthy of the author of those works which have preceded it. It is, in fact, the most complete and comprehensive view of the coal industry of France that has yet appeared.

It commences with a well-written dissertation upon the general position of the coal industry of the world in 1866, and after a rapid survey, in a practical direction of view, of the geographical and geological distribution of coal—in its several classes of anthracite, fat coals, or coal proper, and lignites—and a very interesting chapter upon unproductive coal formations, and another upon the economical conditions necessary to the working of coal pits in France, proceeds to a survey and description, *seriatim*, of all the great coal basins in that country, classed under those of the north, west, east, centre, and south of France, and concludes with a chapter upon the state and condition, social, moral, and material, of the pitmen of France.

The British coal viewer may find in this work some lessons, not without their value to him, of how far science and frugality together can go to make coal measures be worked at a profit, under conditions often where nature has been so parsimonious of her gifts, that were her sparingly given treasures laid before us in England they would probably be neglected altogether.

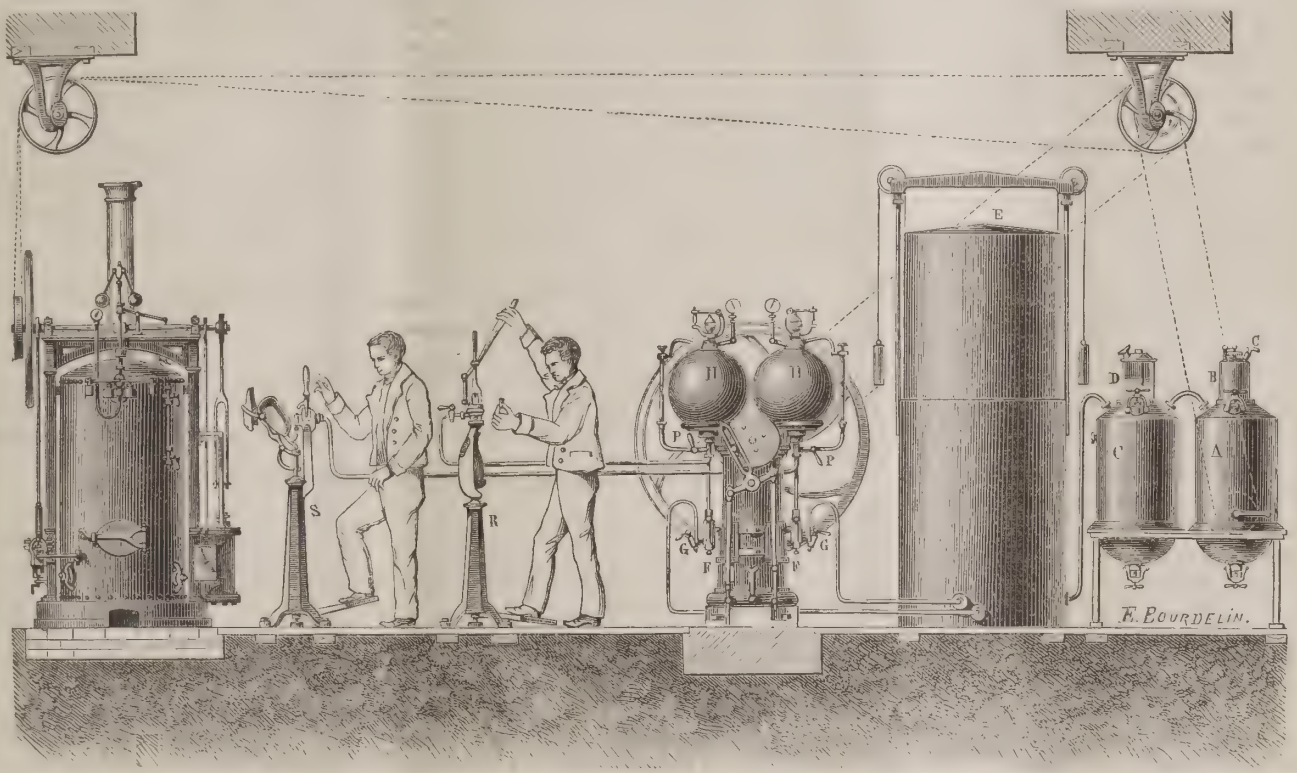
We may learn from it, also, how vast and how progressive is the coal industry of France, which fifty years ago was almost nothing, and what vast industrial interests are in France bound up with it. Lastly, the theoretic geologist may derive many most suggestive thoughts and information pregnant with important theoretic deduction, from the large collection of sections and plans of the various coal basins and coal workings, given so clearly and well in the atlas of plates. Some of these present phenomena of coal formation to which we have nothing analogous in Great Britain. The work is deficient of an alphabetical index, a fault becoming too common in recently published French books.—Ed.

Des Boissons Gazeuses: Guide Pratique du Fabricant et du Consommateur. Par Hermann Lachapelle et Ch. Glover. 2me edition. Paris: Eug. Lacroix.

[Aerated Drinks: a Practical Guide to the Manufacturer and the Consumer.]

The demand on the part of the public for water artificially impregnated with carbonic acid gas has been gradually increasing for some years past, and has led mechanical men to invent numerous contrivances by which that impregnation may be the more easily effected. From the little apparatus covered with cane-work, in which half-a-dozen glasses are prepared for family use, to the elaborate machine which produces 10,000 bottles a day, the step is considerable; but both display ingenuity, and both tend in their several ways to gratify the public taste for aerated water. In the present Exhibition at Paris are to be seen numerous

stalls covered with specimens of the simpler form of apparatus, and of those convenient receptacles which the French term *siphons* (though there is nothing of the siphon about them), and which, when filled at the manufactory, are delivered daily at hotels and private houses. In Paris these siphons are common alike in cheap dining rooms frequented by the humbler classes and in the most expensive hotels; it is only the charges for them that differ. In the one place they are to be had at the rate of three halfpence each, a low charge certainly, but both manufacturer and retailer must have their profit out of it; in the other five times as much usually appears in the bill. There are also specimens in the Exhibition of more elaborate apparatus, and amongst the exhibitors are Messrs. Lachapelle & Glover, the authors of the volume before us. They carry on a large business in Paris as manufacturers of machines for making aerated drinks of every kind—seltzer water, lemonade, sparkling wines, &c. The book under review goes over the whole subject, and has evidently been intended to form a practical manual for the manufacturers of aerated liquids. They describe the apparatus employed, and the best methods of erecting and managing it. A considerable number of woodcuts render the text the more easily intelligible. They then take in turn the mode of making common seltzer water; sugared drinks, such as lemonade; the treatment of wine, beer, and cider, so as to make them sparkling or effervescent. In short, we have a complete treatise on the subject of a branch of industry which is year by year becoming of more importance; and the book will be found of



great use by those commencing the business, or wishing to carry it on upon a larger scale. The annexed woodcut illustrates one of Messrs. Lachapelle & Glover's large sets of apparatus, with two saturating spheres and two pumps. The spheres can either work separately or together, and can be made to saturate two different liquids under different pressures. A is the vessel in which the acid and the carbonated salt are brought into contact, the acid having been first introduced into the upper vessel, B. Both these vessels are of copper lined with lead. C is the vessel in which the purification of the carbonic acid gas is effected. It is of copper coated with tin inside, and it is surmounted by a glass cylinder, D, which serves both as an indicator of the state of the gas and assists in its further purification. From this vessel the gas passes into the gas storer or gasometer, E. By means of the pair of pumps, F, the water and gas are driven into the spherical saturators, H, provided with safety-valves and indicators. The cocks, P, command the passages to the drawing apparatus, where the aerated water is bottled or otherwise disposed of. By means of endless bands the steam engine, here represented as a vertical one, may be made to actuate the agitator in the producing vessel, A, and the pumps, F.

Des Diverses Résistances et autres Propriétés de la Fonte, du Fer et de l'Acier, et de l'Emploi de ces Métaux dans les Constructions. Par G. H. Love. 1 vol. 8vo. Lacroix, Paris. 1867.

This is a tolerably large book, and is valuable to the English engineer as comprising a very well arranged and no doubt tolerably complete *resumé* of what has been effected in the way of experimental determinations of the properties of iron in its several states in resistance to external forces, by the engineers, metallurgists, and physical experimentalists of France. In its pages may be found a good many facts as to the resistance, under various conditions, of cast and wrought iron and steel, new to a large number of English engineers; and in addition to this, many notices of applications and methods of application of these metals to structural or mechanical uses, which are more or less unfamiliar to British mechanics. The work, however, though containing much important matter, now for the first time indeed collected into one volume in France, greatly lacks that scientific *netteté* and clearness of expression and scientific elegance of demonstration that characterizes most French technical and scientific works.

It is also most strangely unequal in its information: indeed, we suspect the author, who is not unknown in France as a scientific experimentalist and writer, is no reader of English, for while he seems acquainted with Tredgold, Hodgkinson, and G. Clark's works, he seems to know nothing whatever of many of the most leading and important investigations that have been made on the resistance of materials, &c., in Great Britain, and indeed we may say the same of Germany. Occasionally this is evidenced in the most startling way; thus, for example, under the head of cylinders exposed to pressure from within, we have Tredgold's old empirical formula, and Barlow's for the thickness, &c.; there is not one word said as to the more recent investigations—to those of Hart, Mallet, Scheffler, and others, on the strength of such cylinders, nor of the building up of such cylinders by concentric shrunk-on rings, now practised as results of those investigations. We might quote, were there any use in it, very many other examples of this *bizarre* mixture of knowledge and ignorance.

After Hodgkinson and Fairbairn there is no man in Great Britain, probably, who has made and published, to say the least, so numerous a collection of experiments as Mr. Kirkaldy, whose *facts* are of very great value, whatever other opinion we may entertain of several of his hasty

or imperfect generalizations from them; but Kirkaldy's name is not even so much as once alluded to that we have seen, and the same thing is true of other important British trains of experiment by others. The volume wants also an alphabetical index, and is in style greatly below the usual standard of Lacroix production. However, there it stands, a collection of many facts, previously scattered through a wide region of French literature. It would be to do good service now to cull out what is valuable from this and our English books on the subject, and also from the German ones, and condense all into one standard volume; the task would be one of vast labour, however, to be done as it should be, and as, if done, it would alone be of real value.—Ed.

THE PARIS EXHIBITION DISTRIBUTION OF PRIZES.

GRAND PRIZES.

The following is the list of grand prizes which the Emperor distributed to the more noteworthy exhibitors, on Monday, July 1. The ceremony took place within the Palais de l'Industrie:—

Group I.—*Fine Arts.*—Gabanel, Gérôme, Ernest Meissonier, and Théodore Rousseau, France; Guillaume de Kaulbach, Bavaria; Knaus, Prussia; Leys, Belgium; Ussi, Italy; Eugène Guillaume and Perraud, France; Drake, Prussia; J. Dupré, Italy; Ancelet, France; Ferstel, Austria; Waterhouse, England; Alphonse François, France; J. Keller, Prussia.

Group II.—*Materials of the Liberal Arts.*—Alfred Mame & Son, books and binding, Tours, France; Japan, paper, industrial arts, lacker, culture of the silk-worm; De Jacobi, application of galvano-electricity to the arts, St. Petersburg; Garnier, heliographic engraving, Paris; Adolphe Sax, wind instruments in brass, Paris; J. L. Matthieu, surgical instruments, Paris; Father Secchi, meteorograph and meteorological and astronomical labours, Pontifical States; Brunetti, anatomical preparations, Padua; Eichens, astronomical instruments, Paris.

Group III.—*Furniture.*—Fourdinois, furniture and tapestry, Paris; Klagman, works of art; Baccarat Company, crystals, France.

Group IV.—*Clothing.*—City of Lyons, institutions created to favour silk manufacture, Paris.

Group V.—*Raw Materials.*—Krupp, cast steel, Essen, Prussia; Petin & Gaudet, cast steel and iron, Rive-de-Gier; Schneider & Co., iron, Le Creusot; Japy Brothers, hardware, lockwork, and clockwork, Beaucourt, France; Bessemer, manufacture of steel, London; Iriana, collection of medicinal and industrial plants, Bogota, New Granada; Algeria, cultivation of cotton; Brazil, do.; Egypt, do.; Ottoman Empire, do.; British India, do.; Italy, do.; A. W. Hoffmann, discovery of aniline colours, Berlin.

Group VI.—*Machinery.*—Schneider & Co., working of coal mines, forges, and foundries of Le Creusot; Kind & Chaudron, procedure of bracketing the shafts of the Saint-Avold Company, Saxony and Belgium; C. W. Siemens, gas stoves, London; C. F. Hirn, telodynamic cables, Logelbach, France; Farcot & Sons, steam-engine, Saint-Ouen; Whitworth & Co., machine tools, Manchester; P. Meynier, loom for weaving flowered silk, Lyons; P. Viguier, railway signals, Paris; Cyrus Field and the Anglo-American Companies of the Transatlantic Cable; the Transatlantic Cable, United States; Hughes, telegraphic printing, New York; Universal Company of the Maritime Canal of Suez, models and designs, Paris; F. Hoffmann, annular brick kiln, Berlin.—British Life-boat Association, organization of means for saving life, creation of the material, England; New Society of foundries and workshops of the Mediterranean, models of ships and naval engines, Paris; R. Napier & Son, models of ships, Glasgow; J. Penn & Son, marine steam-engines, Greenwich.

Group VIII.—*Horticulture.*—Pasteur, method of preserving wines by heating, Paris; H. Marès, propagation of the procedure of sulphuring the vine, Montpellier.

Group IX.—*Agriculture.*—Emperor of Russia, improvement of the equine race.

Group X.—Objects recommended by their useful qualities, combined with cheapness, and productions, the object of which is the improvement of the physical and moral condition of the people:—The Emperor of the French, workmen's houses, model farms; Geneva Committee, founder of the international work of succour to wounded soldiers. Documents, statutes, and material, Switzerland; Sanitary Commission of the United States, material having served in the war of 1861, United States; Henri Dufresne, damascene engraver; new method of gilding on copper and silver without danger to the workmen, Paris.

GOLD MEDALS.

The following is a list of the names of all English exhibitors who obtained gold medals:—

GROUP I.—FINE ARTS.

Class 4.—Grand prize, A. Waterhouse.

GROUP II.—APPARATUS AND APPLICATIONS OF THE LIBERAL ARTS.

Class 6.—Printing and books—Gold medal, V. Brooks.

Class 7.—Paper, stationery, binding, painting and drawing materials—Gold medals, Cowan & Sons, and T. H. Saunders.

Class 8.—Application of drawing and modelling to the common arts—Gold medal, Department of Science and Art, South Kensington.

Class 10.—Musical instruments—Gold medal, Broadwood & Sons.

Class 11.—Medical and surgical instruments and apparatus—Gold medal, Ash & Sons.

Class 12.—Mathematical instruments and apparatus for teaching science—Gold medals, Dallmeyer, T. Ross, R. & J. Beck, and Chance Brothers.

GROUP III.

Classes 14 and 15.—Fancy furniture, upholstery, and decoration work—Gold medals, Wright & Mansfield, and Owen Jones, decorative architect.

Class 17.—Porcelain, earthenware, and other fancy pottery—Gold medals, Minton & Co., and W. Copeland & Sons.

Class 18.—Carpets, tapestry, and other stuffs for furniture—Gold medals, British India, J. Templeton, and Brinton & Lewis.

Class 19.—Paper-hangings—Gold medal, C. & J. G. Potter.

Class 20.—Cutlery—Gold medal, Brookes & Crookes.

Class 21.—Gold and silver plate—Gold medals, Elkington & Co., Hunt & Roskell, C. H. Hancock, and Morel-Ladeuil, co-operator.

Class 23.—Clocks and watches—Gold medals, J. Poole, Victor Kulberg, and Parkinson & Frodsham.

Class 24.—Apparatus and processes for heating and lighting—Gold medal, Windfield & Co.

GROUP IV.

Class 27.—Cotton thread and fabrics—Gold medals, Collective Exhibition of Scotland and England, Armitage & Sons, H. Bazley, Radcliffe & Co., and Horrockses, Miller, & Co.

Class 28.—Thread and fabrics of flax, hemp, &c.—Gold medals, Belfast Chamber of Commerce, Charley & Co., Fenton, Sons, & Co., and J. S. Brown.

Class 29.—Combed wool and worsted fabrics—Gold medals, Bradford Chamber of Commerce, and J. Ackroyd & Sons.

Class 30.—Carded wool and woollen fabrics—Gold medals, Cloth manufacture in the south of Scotland, and manufacturers of the west of England for the towns of Gloucestershire and Wiltshire.

Class 31.—Silk and silk manufactures—Gold medal, Great Britain.

Class 32.—Shawls—Gold medal, Dewan Sing.

Class 33.—Lace, net, embroidery, and small ware manufactures—Gold medal, town of Nottingham.

Class 34.—Hosiery and underclothing, and articles appertaining thereto—Gold medal, M'Intyre, Hogg, & Buchanan.

Class 36.—Jewellery, precious stones, &c.—Gold medal, Phillips.

GROUP V.

Class 40.—Mining and metallurgy.—Gold medals, J. Brown & Co., Johnson, Matthey, & Co., Bowling Iron Company, Barrow, Low Moor Company, Lilleshall Company, New South Wales Commission, Burys & Co., Monkbridge Iron Company, and Thomas Turton & Sons. Co-operators, Grand prize, Bessemer.

Class 41.—Products of the cultivation of forests, and of the trades appertaining thereto—Gold medal, Abbé Brunet.

Class 43.—Agricultural products (not used as food) easily preserved—Grand prize, British India; gold medal, Towns.

Class 44.—Chemical and pharmaceutical products—Gold medals, C. Allhusen, Gossage & Sons, Muspratt & Sons, Jarrow Chemical Company, Howard & Sons, Price's Patent Candle Factory, and J. Young.

GROUP VI.

Class 48.—Agricultural apparatus—Gold medals, J. & F. Howard, Clayton, Shuttleworth, & Co., J. Fowler & Co., R. Garrett & Sons, Ransomes & Sims, and R. Hornsby.

Class 51.—Apparatus used in chemistry, pharmacy, and in tanyards—Grand prize, C. W. Siemens; gold medal, Johnson, Matthey, & Co.

Class 53.—Machines and apparatus in general—Gold medal, Merryweather & Sons.

Class 54.—Machine tools—Grand prize, Whitworth & Co.; gold medals, Sharp, Stewart & Co., Shepherd, Hill, & Co.

Class 55.—Apparatus and processes used in spinning and rope-making—Gold medals, S. Lawson & Sons, and Platt Brothers & Co.

Class 56.—Apparatus and processes used in weaving—Gold medal, Howard Bullough, J. Leeming & Sons, and G. Hodgson.

Class 61.—Carriages and wheelwright's work—Gold medal, T. Peters & Son.

Class 63.—Railway apparatus—Gold medals, Kitson & Co., R. Stephenson & Co., and Saxby & Farmer.

Class 64.—Telegraphic apparatus and processes—Grand prize, Anglo-American and Transatlantic Cable Company; gold medals, W. Hooper and W. T. Henley.

Class 65.—Civil engineering, public works, and architecture—Gold medals, Chance Brothers, Minton & Co.

Class 66.—Navigation, marine engines, life-boats, &c.—Grand prizes, Royal National Life-boat Institution, R. Napier & Sons, J. Penn & Son; gold medals, Laird Brothers, Maudslay, Sons, & Field, Thames Ironworks Company, Randolph, Elder, & Co., Samuda Brothers, Humphrys & Tennant, and E. Clark.

GROUP VII.

Class 67.—Cereals and other eatable farinaceous products, and the products derived from them—Gold medal, A. Bell.

Class 70.—Meat and fish—Gold medal, Commission of Nova Scotia.

Class 72.—Condiments and stimulants, sugar and confectionery—Gold medals, E. Hery, C. Wulve, H. Pitot, district of Assam, districts of Cachar, of Dehra Dhoon, Kumaon, Bengal, and of Neilgherry Hills.

Class 73.—Fermented drinks—Gold medals, Allsopp & Sons, and Bass & Co.

GROUP X.

Class 90.—Gold medal, Book Hawking Union, South Kensington.

CORRESPONDENCE.

INSTITUTION OF CIVIL ENGINEERS.

THE following letter has been issued by the Council of the Institution to its members and associates. We cordially agree with the provisions now made for the better education of the student branches of our profession; and if the facilities offered to juniors for gaining the highest standard information our country possesses are properly administered, we venture to hope that we may anticipate a better informed and a more thorough-going rising generation of engineers.—V. D.

25 GREAT GEORGE STREET, WESTMINSTER, S.W.
16th July, 1867.

DEAR SIR,—I am instructed to forward a copy of the bye-laws and regulations of the Institution of Civil Engineers, as amended and enlarged at a general meeting of members held here, pursuant to notice on Wednesday the 26th day of June last; and I am particularly to direct your attention to Section IV., respecting the admission of students.

With a view of increasing the usefulness of the Institution, particularly to the junior members of the profession, it has been decided, you will observe, to create a Student class, to take very much the place of that which was formerly the Graduate class, but with certain modifications, so as to avoid the difficulties which previously arose, and to provide those advantages which experience has pointed out to be desirable.

Although not specifically mentioned in the rules, it is contemplated to grant, under the control of the Council, the use of the theatre of the Institution to the students, for supplemental meetings for the reading and discussion of papers among themselves, and possibly, also, for the delivery to them of lectures upon special subjects; the object of such supplemental meetings being for the advancement in scientific and technical knowledge of the junior members.

Believing it to be of the highest importance that the profession should not be divided, but should remain one united body, having a position and an influence which one united body only can have, the Council trust that you will cordially unite with them in the endeavour so to extend and enlarge the basis of the Institution, as that it shall continue to embrace within it all branches of engineering and all classes of engineers.

In case you may know any gentlemen wishing to avail themselves of the privileges of the Institution and of these new arrangements, I have been directed to send to you one copy of the form of proposal for ordinary candidates desirous of joining the Institution, and two copies of the form of application for the admission of students.

I am, dear Sir,

Yours faithfully,

JAMES FORREST, *Secretary*.

OBITUARY.

DIED at Paris during the past month, B. Fourneyron, the well-known mechanical engineer of France. The creator of the turbine which bears his name, he so improved upon what had been done before, and, as always is the way with men of true mechanical genius, left his work so perfect, that he might almost be recognized as the inventor of the turbine, or reaction water-wheel with vertical axis of revolution. Fourneyron was born in 1802, and in 1817 entered the *Ecole des Mines*, where he became mathematical *répétiteur*, and whence he emerged two years after with the highest honours the institution could confer upon a pupil. He was returned a deputy for the department of the Loire in the stormy days of 1848. Death reached him while engaged in his duties as juror at the Exhibition.

During the past month, too, death has also carried off another distinguished in this country as a leader in his particular profession, William Carpmael, the well-known patent agent. Mr. Carpmael was for a long series of years largely consulted by many of our most fortunate inventors, besides engaged on questions of technical evidence in the most important litigations on patents.—V. D.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

ON THE "FLOW OF SOLIDS," WITH THE PRACTICAL APPLICATION IN FORGINGS, &c.

By M. TRESCA.

ALTHOUGH we have in the pages of this journal that have appeared since February 1, 1866, given at much length successive portions of M. Tresca's valuable researches on this subject, we are still sure that the following condensed abstract of a paper read by him before the recent meeting of Mechanical Engineers at Paris, will be welcomed by most of our readers.

It is now some years since a numerous series of experiments were made by the writer on the change of form of solid bodies, which have led to characterizing the general results thus obtained by the title of the "Flow of Solids" under the action of powerful pressure. The first paper relating to this subject was read by the writer before the Academy of Sciences at Paris, in November, 1865; and the views then advanced have been continuously corroborated by the results of a great variety of further experiments made by the writer. The question now includes consequences of great diversity; and the special object of the present paper is to make known the most salient facts required for explaining some important practical applications upon which this theory appears to the writer likely to throw new light, such as the rolling, forging, punching, and planing of metals.

Principle of the flow of solids.—If a hollow cylinder, closed at the bottom end, have a solid cylindrical block of lead placed inside it, fitting it, and the hollow cylinder have a round hole in the centre of the bottom, a powerful pressure on the top of the solid block will produce a circular jet of metal, having a sectional area equal to the hole in the bottom of the cylinder. M. Tresca having described the apparatus he first used to attain this result, next stated that in most of the experiments the block of lead operated upon consisted of a series of superposed plates or discs of uniform thickness, and the change of form was distinguished by the following facts:—

First, in the main block the parallel faces of the different discs remain either entirely flat, or flat over all the surface that is outside the part affected by the formation of the central jet.

Secondly, in the part constituting the jet, or the truncated cone in which the layers curve and converge to form the jet before passing through the orifice, all the layers bend over so as to enter into the jet simultaneously, as though they individually followed a general current directed towards the orifice.

Thirdly, as far as the jet is concerned, its external surface is entirely composed of a cylindrical envelope formed out of the bottom disc of the original mass.

Fourthly, each of the original layers forms in the jet a distinct tube, concentric with the jet, and occupying in the jet a concentric position between the tubes thus formed by the other layers.

Fifthly, each of these tubes is closed at the outer extremity by a cap more or less convex, which is the central part of each of the original discs.

The same results having been obtained by the writer with various other metals —such as tin, silver, copper, aluminium, iron, and even steel, as also with different kinds of potter's clay, sand, powdered sugar, and small shot—the general conclusion has been arrived at, that the particles of solid bodies, when submitted to a sufficient pressure, flow in the same way as liquids; and as the resulting jets from each experiment remain in a permanent state, this has allowed of establishing the fact that the flow of the different strata of the cylindrical mass under these conditions produces a tubular and concentric form of jet, which M. Tresca illustrated by diagrams.

M. Tresca next proceeded to describe some of the experiments he had made, and he exhibited the specimens he had obtained. The following is one of the experiments:—

A cylinder formed of two discs of iron, 0·04m. thick (1½ in.), and 0·15m. diameter (6 in.), was heated to a red heat, but not so high as a welding heat. These discs were placed one upon the other in a cylindric die, having at its base a hole 0·05m. diameter (2 in.), and were then compressed by a steam hammer weighing twelve tons. At the third blow the die broke, but the iron had already formed a jet of 0·065m. length (2½ in.); and on making a longitudinal section of the whole, it was found that, instead of only the single line of joint anticipated from the use of two discs, every one of the parallel layers in the iron plate of which each disc was formed had flowed independently, so as to produce a series of lines in the same way as with the number of separate plates employed in the experiments with lead.

Polygonal orifices and eccentric circular orifices have been successively used; and in both cases it was invariably found that the superposed plates which constituted the primitive block became transformed into a series of tubes fitting into one another, each disc producing a corresponding tube.

Amongst this class of experiments, special reference was made to trials made with double orifices, the results obtained in these cases being remarkably characteristic. The die having two circular orifices drilled in it, of the same diameter, and placed symmetrically with regard to the axis of the block, there are necessarily two planes of symmetry perpendicular to each other; and hence two perfectly equal jets might be expected to be produced, each consisting of a series of tubes arranged in the same manner. This, however, was not found to be the case, but one of the jets was much shorter than the other; and on taking the block out of the die the small streaks visible on the upper surface of the block showed that at the end of the operation the general motion was directed from all points of the upper portion of the block towards the orifice which had produced the longer jet.

M. Tresca gave the results of numerous experiments with dies containing many holes instead of one. The general effects produced may be gathered from one experiment with a die having a circular orifice in the centre and six smaller holes arranged around it, the diameter of the block being only 0·03m. (1·18 in.). In this case the tubes of the central jet, instead of being circular in transverse section, were hexagonal, the rounded angles of the hexagon corresponding with the positions of the six smaller jets. A similar alteration of form was observed in the discs composing the block, which were depressed into grooves radiating from the centre towards each of the smaller orifices, with a well-defined elevation intervening between each groove, and the same effects were produced with great regularity in a number of trials.

M. Tresca stated that jets have also been formed with ceramic compositions, employing a die having a circular hole drilled in the centre, and three smaller holes arranged round it in the angles of a concentric equilateral triangle. The separating

surfaces of the layers were rendered visible in these cases by powdering each disc with finely pulverized *fuschine* or calcined red sand before making up the block.

The speaker then proceeded to detail the results of experiments on the "Flow of solids through lateral orifices," which establish the following conclusions:—

First, that the pressures exerted on the surface of a solid body are transmitted throughout the whole interior of its mass, and tend to produce in it a flow which is propagated from particle to particle, and which necessarily developes itself in the direction where the obstacles to the flow are least.

Second, that the pressures thus transmitted determine in a fixed order the expulsion of the material through the orifice, and the changes of form at each point.

Third, that the transmission of pressure is unequally distributed, as the particles situated at the orifice do not participate in the flow to the same extent.

Fourth, that a loss of pressure thus takes place, which is variable; so that for solids even more than for liquids it may be said that there is a loss of pressure between one point and another during the change of form. The examples of hollow jets show that there are even points where the loss of pressure is carried so far that the pressure becomes *nil.* The experiments in forging subsequently referred to will even give in certain instances the measure of this loss of pressure, and allow of pointing out precise rules corresponding to each of the changes of form that may be effected by mechanical action.

M. Tresca next referred at length to the application of the principles to rolling, stating that rolling produces the same result on metals as combing on textile substances, and constitutes a sort of spinning without torsion; but the bundle of contiguous filaments thus obtained is bound together by their adherence, and in the majority of cases by their welding together. These elementary filaments, which are large and irregular after the first passage through the rolls, become drawn out and reduced simultaneously with the entire bar formed by their union. They are found also, under the form of extremely fine lines, in wire from the rolls or afterwards drawn cold.

The structure of iron, as composed of contiguous filaments, appears to the writer to afford an explanation of the causes of the transformation of fibrous iron into crystalline iron after long use; and he thinks that filaments of different natures may also differ in hardness, and that the facets seen in the fracture of crystalline iron are nothing but surfaces, caused by friction between the particles, arising in the molecular vibrations and consequent elastic changes of form to which iron may be subjected, according to the use it is put to.

The author then drew attention to the internal changes effected by forging. In considering the internal changes of form produced in the operation of forging, the work operated upon, whatever its form, may be considered for the present purpose as composed of a series of cylindrical elementary layers inclosing one another. When a portion of one of the former experimental jets is taken, composed of a series of concentric lead cylinders, and is subjected to a lateral hammering, each blow of the hammer produces a flattened place, which spreads the exterior layers laterally, and causes them to enlarge gradually in circumference and become loose from one another. This unsheathing of the tubes by forging on the outside can be made to extend to a greater or less depth according to the character of the blows; to disengage the exterior layers only very light blows are required, in order that the disturbing force may act only upon the exterior layers to produce flow of material. Thus forging by external blows does not produce the effect of drawing the whole cylinder as a mass; and in order to obtain this result it is requisite to prevent all lateral flow of the material by some means, such as the use of dies, which may thus be considered to act as guides for forcing the material to flow longitudinally.

For the purpose of examining practically the effects produced in different kinds of forgings as to the changes in their internal arrangement, the writer has prepared numerous sections of several different descriptions of work made for this special object: the specimens themselves were also exhibited.

In fine, the conclusions arrived at by M. Tresca are as follows:—

First, that solid bodies can be modified in form according to fixed laws when sufficiently powerful external forces are brought to bear upon them; and that, by employing obstacles, such as dies, for compelling the changes of form to take place in a fixed direction, a jet is produced which may be exactly compared to the jets occasioned by the action of gravity in liquids.

Secondly, that the flow of liquids themselves is only a particular case of the action of the forces exerted upon them, and that, consequently, the conditions of the flow of solid bodies ought to lead to more exact knowledge respecting the flow of liquids; and the method of observation employed by the writer, by subdividing the original mass into a number of distinct parts, allows the movement of separate particles in the successive changes of form to be traced throughout the phenomena of the flow.

Thirdly, that the variations made in the shape of the orifices have afforded the means of discovering movements of rotation round the axis of the jet when the orifice is polygonal or eccentric; and by increasing the number of orifices the reciprocal influence of the jets upon one another can be ascertained, and the geometrical arrangements rendered manifest which result from the transmission of the pressures in the interior of the mass, and from the losses of pressure, which vary according to the direction. Also by causing the metal cylinders to flow through lateral orifices, extremely regular changes of form were obtained, bearing a certain relation to those obtained in the concentric longitudinal jets. The following law may therefore be considered of general application:—That when pressure is exerted upon the surface of any material it is transmitted in the interior of the mass from particle to particle, and tends to produce a flow in the direction where the resistance is least.

Fourthly, that by means of oxidizing the sections of forged and rolled iron the movements of the interior particles are shown to follow the same laws as in the previous experiments on the flow of solids; that in rolling all the elements of the original piece are drawn out individually and in parallel lines, from the surface to the very centre of the bar, when the external force is powerful enough. The rolling of metals may therefore be compared to the operations of combing and drawing employed in spinning; and a rolled iron bar may be considered as a bundle of threads or fibres, which preserve their original individuality, and clearly constitute the fibrous property of certain qualities of iron, while iron plates are formed of a series of distinct sheets placed on the top of one another, and the more or less perfect welding of these sheets determines the quality of the plate.

Fifthly, that the friction of the surfaces by which the pressure is applied may be made use of to reduce the change of form in particular directions, which accounts for a plate preserving the same width during its successive passages through the rolls.

Sixthly, that the changes of form produced in forging may be considered as the results of successive flowings effected by each of the individual forces exerted upon the work forged. The weight of the hammer, the height of its fall, and the form and state of its face, require therefore to be adjusted relatively to one another in the manner most favourable for producing the desired effect; the intensity of the blow determining the depth to which its effect penetrates, the form of hammer face determining the breadth of surface over which the blow is spread, and the state of its face determining the amount of friction to resist lateral spreading under the blow. Also, in order to prevent other changes of form from occurring besides those intended, it is requisite to apply accessory resistances by means of dies or swages, which may be looked upon as channels left open to allow of the material flowing in the direction desired.

Finally, that in every case these changes of form take place from particle to particle, according to a geometrical order which admits of mathematical calculation. The tendency of actual practice in manufacturing processes is to realize, as far as possible, the best conditions for effecting the required changes of form; and the theory of the flow of solids, by giving the means of proving the effect due to each cause, may be expected to lead to the adoption of definite rules in place of the present empirical methods. The writer hopes that his efforts in this direction may be considered as a useful step towards facilitating the improvements in metallurgical industry which are being so actively pursued both in France and England.

THE ROYAL SOCIETY.

ON UNIFORM ROTATION. By C. W. Siemens, F.R.S., Mem. Inst C.E.

(*Continued from page* 124.)

Clock regulated by liquid in rotation.—This clock is represented by figs. 4 and 5, and consists of three principal parts:—

1. The pedestal containing a battery of two "Marie Davy's elements" suitably arranged.

2. The body of the clock, with sides formed of plate glass, containing an electro-

Fig. 10.

Fig. 6.

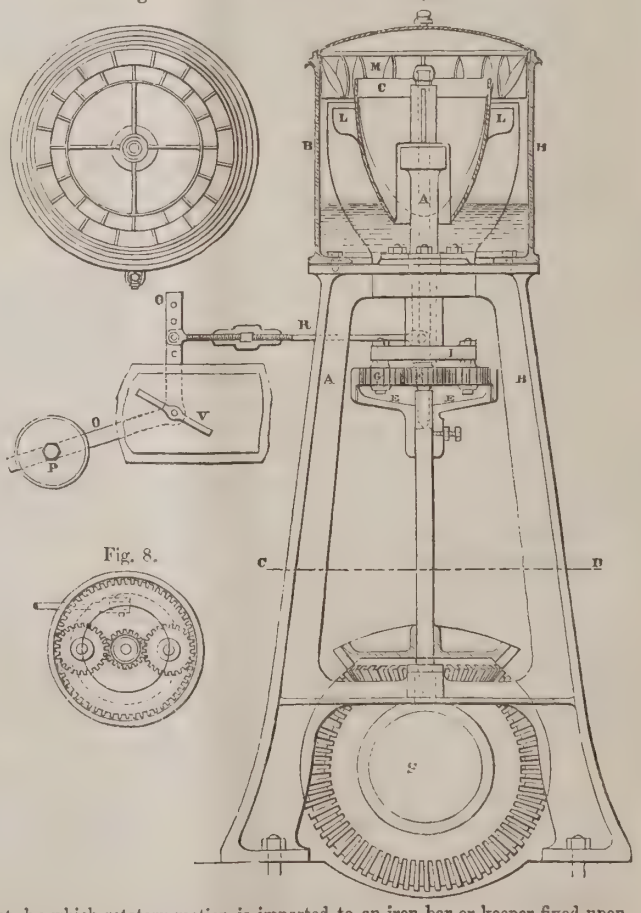


Fig. 8.

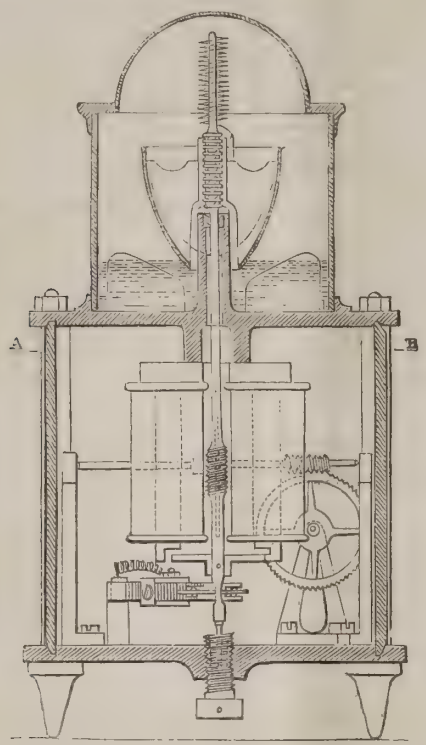
magnet, by which rotatory motion is imparted to an iron bar or keeper fixed upon the vertical main axis which passes into

3. The regulating chamber, consisting of a close cylindrical glass vessel with domed glass top containing the rotating cup and a certain quantity of paraffin oil, which fluid is particularly applicable on account of its perfect fluidity and non-affinity for the materials composing the regulator.

The regulating cup is in this instance formed of vulcanite, and is suspended from the top of the vertical axis by means of a spiral spring, which, being fixed at both ends, not only supports the weight of the cup but acts also as a torsional spring, enabling the cup to descend upon its helical central guide whenever an increase of driving power calls into existence its equivalent of torsional resistance.

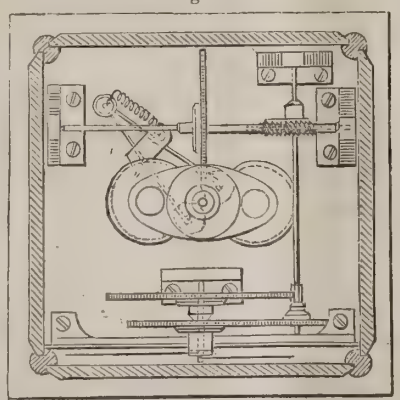
The rings of stationary and rotating vanes are dispensed with in this instance,

Fig. 4.



because no great variations in the driving power are contemplated. The electro-magnet acts by attraction of the armature during a small portion of its rotation, and one contact only is required, which is so arranged that no destruction of the metallic surfaces can arise through the discharge of extra-current sparks, which latter are received by an elastic point of platinum slightly in advance of the proper contact surface and moved by the same excentric. By this simple arrangement

Fig. 5.



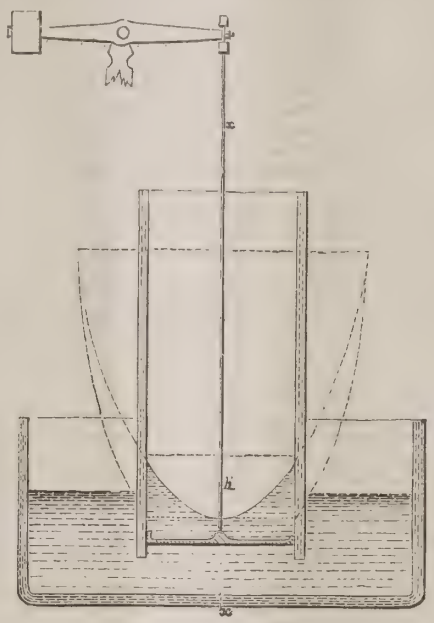
the usual difficulty attending dry contacts is avoided, and a continued action of the instrument insured. A train of reducing wheels communicates the motion of the cup spindle to hands upon the face of the clock, which record hours and minutes in the usual manner.

The diameter of the rotating cup being = 0·040 metre, and the height of its edge over the surface of the liquid = 0·034 metre, the number, n, of its rotations per second in accordance with our formula

$$n = \frac{\sqrt{19{\cdot}6 \text{ metre} \times {\cdot}038 \text{ metre}}}{{\cdot}040 \text{ metre } \pi} = 6{\cdot}9 \text{ revolutions per second.}$$

Experiment gave, on the contrary, a speed of 7·5 revolutions per second, or ·6 revolutions per second more than was indicated by theory, a result which seemed to stamp the action of the instrument with uncertainty, when it was recollected that no allowance had been made for the aperture at the bottom of the cup, leaving a portion of the rotating liquid without an external support.

Correction for lower orifice of Cup.—If we assume, for instance, that the sides of the cup were cylindrical and merely descended below the surface of the liquid without closing in at the bottom, we should find that by rotation of this cylinder, supposing the inner surface to be rough or armed with radial projections, the liquid would rise on the circumference above the external level of surface, but would also form a depression or vortex in the centre of rotation. The surface of the rotating liquid would be that produced by the rotation of a vertical parabola, as represented in the accompanying diagram. In order to maintain the hydrostatic equilibrium between the rotating column with the external liquid, it is necessary that its mean height of column must remain the same, or that the plane of external liquid level must divide the solid figure comprised between the cylinder and the curve of rotation into equal parts. In order to realize these conditions experimentally, it would



be necessary to provide the lower portion of the rotating cylinder with an easy fitting and balanced piston, without which circular currents would be produced within the rotating liquid (descending by force of gravity at the sides, and rising again in the centre) and mar the result.

The body comprised between a paraboloid of the height, h', and a cylinder is, however, divided equally by a horizontal plane cutting it at the distance of $\frac{h'}{\sqrt{2}}$ from the edge, or at

$$h' - \frac{h'}{\sqrt{2}} = {\cdot}293\, h'$$

from the apex. The form of the curve depends upon the angular velocity alone, and would remain the same if the upper diameter of the tube were to be increased, only the curve would in that case have to be continued until it met the sides (as shown by dotted lines), and to the extent of these prolongations the liquid would be raised higher above the external level without producing a corresponding depression in the centre of rotation.

It follows that the aperture at the bottom of the rotating cup causes a vortex or depression of the apex of the curve of rotation below the external liquid to the extent of ·293 part of the height due to its own diameter, and to the correct number of rotations, n', per second.

It is

$$n' = \frac{\sqrt{2g\,(h + {\cdot}293\, h')}}{2r\,\pi}$$

and also

$$n' = \frac{\sqrt{2g\,h'}}{2\varrho\,\pi}$$

if ϱ is the radius of lower aperture of cup; therefore

$$\frac{\sqrt{2g\,(h + {\cdot}293\, h')}}{2r\,\pi} = \frac{\sqrt{2g\,h'}}{2\varrho\,\pi},$$

or

$$h' = h\,\frac{\varrho^2}{r^2 - {\cdot}293\,\varrho^2},$$

and in substituting this value for h' into the first formula, we have

$$n' = \frac{\sqrt{2g\,h + 2g\,h\,\dfrac{\varrho^2}{r^2 - {\cdot}293\,\varrho^2}}}{2r\,\pi},$$

or

$$n' = \frac{\sqrt{2g\,h\left(1 + \dfrac{\varrho^2}{r^2 \times {\cdot}293\,r^2}\right)}}{2r\,\pi}, \quad \ldots\ldots \text{(V.)}$$

for our *corrected formula to determine the velocity of cup with continuous overflow.*

In applying this formula to the clock, taking for ϱ its value of 8 millims. and the other values also in millimetres in order to avoid fractions, we find

$$n' = \frac{19600 \times 38 \left(1 + \frac{64}{400 - 16{\cdot}05}\right)}{40\,\pi} = 7{\cdot}4 \text{ revolutions per second,}$$

or ·1 revolution per second less than the actual speed. The remaining excess of *actual* over the *calculated* velocity of the cup is rather more than what may be fairly attributed to error of measurements, and appears to be due to adhesion of a film of liquid (which may be estimated at nearly ·25 millimetre thickness) to the inner sides and edge of the cup, whereby its *effectual* dimensions are proportionately reduced. For a uniform speed this error must be a constant quantity, which cannot affect the working of the instrument injuriously, so long as the other conditions are such as to produce uniform rotation. The discrepancy is diminished by increasing the dimensions of the cup, and its amount is such that the compensation is effected, under all circumstances, by one or two turns of the regulating screw supporting the vertical spindle.

When the regulation of the cup is once effected, it continues to rotate at a remarkably uniform rate. Change of temperature affects the density of the liquid considerably, but does not influence the rate of the cup otherwise than inasmuch as it affects the level in the cup chamber, which will rise with increase of temperature proportionately to the depth of liquid it contains, and which is inconsiderable. The lineal dimensions of the cup, and the length of the suspending spring, will also increase, all tending to lower the rate with increase of temperature; but, on the other hand, the length of the upright cup spindle increases with increase of temperature, and in regulating the length and composition of that spindle properly, entire compensation for change of temperature is effected. The cup chamber being entirely closed against the atmosphere, no fault can arise through evaporation or dispersion of the liquid within moderate periods of time.

In the case of the clock under consideration, no compensation for change of temperature was provided, nor is the cup entirely balanced by the spring, yet its rate is as uniform as that of the common clock with which it has been compared; but in order to test the regulating power of the instrument, the driving power was varied by the introduction of artificial resistances into the galvanic circuit, when the following results were observed:—

Time of Common Clock, in Seconds.	Mercury Units of Resistance of Clock and Battery.	Units of Resistance put into Circuit.	Relative Value of Driving Power.	Time of Liquid Gyrometer Clock, in Seconds.	Variations in Time Produced in Seconds.
720	110	0	100	736	16 slow.
720	110	10	92	734	14 "
720	110	20	85	734	14 "
720	110	30	78	733	13 "
720	110	40	73	732	12 "
720	110	50	69	731	11 "
720	110	60	64	729	9 "
720	110	70	61	726	6 "
720	110	80	58	723	3 "
720	110	90	55	720	Correct.
720	110	100	52	723	3 fast.
720	110	110	50	726	6 "
720	110	120	48	725	5 "
720	110	130	46	724	4 "
720	110	140	44	722	2 "
720	110	150	42	729	9 slow.
When the overflow had ceased.					

This result shows that the spring employed was decidedly too weak, producing a *decrease of speed* with *increase of power*.

A more careful adjustment of the spring would improve these results, which suffice, however, to prove the capabilities of the instrument.

It appears at first sight as though the friction of the cup upon the threads of the screw must interfere with its automatic adjustment; but this is practically not the case, owing to the circumstance that small fluctuations in the resistance continually occur, causing torsional oscillations of the cup, the mean of which must be its true position notwithstanding friction, which friction moreover is reduced to a minimum, owing to the suspension of the weight by the spring.

Another interesting quality of the gyrometric cup is its comparative indifference to a vertical position; it may, indeed, be tipped very considerably without interfering with the uniform overflow all round, and the time of its rotations is diminished only in the ratio of the square roots of the vertical mean heights, or it is

$$n' : n = \sqrt{h} : \sqrt{h \cos \beta},$$

or for a tipping angle $\beta = 3°$,

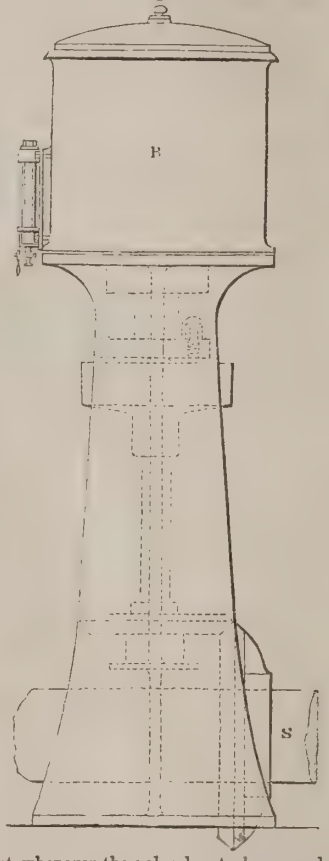
$$n' : n = 1 : 1{\cdot}0007,$$

showing that no particular care is requisite to place the instrument upon a horizontal foundation.

Gyrometric Governor.—The most useful practical application of this instrument is that of regulating the power and velocity of steam engines. A cup of very large dimensions, provided with several belts of check vanes and with the automatic dip arrangement, might be conceived which, in being connected by gearing with the main shaft of an engine, would limit its velocity by absorbing directly all its surplus power. This surplus power would appear in the cup chamber in the form of molecular motion or heat, and would have to be got rid of by the application of cooling agents, if the natural dispersion of heat by radiation would no longer suffice to keep down the temperature. This would, however, be a wasteful proceeding, and it becomes necessary to operate, not upon the power produced, but rather upon the source of power, by rendering it always equal to the accidental resistance or load in order to maintain uniform velocity. The arrangement adapted for this purpose is represented by figs. 6, 7, 8, 9, and 10.

S is the main shaft of the engine, which imparts motion to the upright spindle, H, carrying an inverted wheel, E. The

Fig. 7.

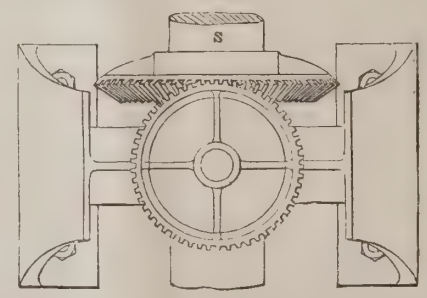


axis, A, of the regulating cup, being concentric with the spindle, H, carries a pinion, F, and both the wheel and the pinion gear into two intermediate or planet wheels, G and G′, which latter are loose upon studs and are suspended from a rocking frame, I, the latter being free to turn upon its central support. The rocking frame, I, is connected by a rod, R, to a bell-crank lever, O, which is fastened upon the spindle of the steam regulating or throttle valve, V; but the horizontal arm of the lever, O, carries a weight, P, which, being acted upon by gravity, tends to open the valve and at the same time to force the rocking frame, I, with its planet wheels, G and G′, round the vertical axis. This pressure is resisted, on the one hand, by the teeth of the pinion, F, which can only yield in the ratio imposed by the rotating cup, C, and on the other hand, by the teeth of the inverted wheel, E, which latter, being driven round by the engine in the direction contrary to the effort produced by the weight, P, causes the latter to be continually raised. If the engine should succeed in raising the weight, P, say 100 millims., while the regulating cup yields also to the extent of 100 millims., then the lever, O, and with it the regulating valve, V, will retain their relative position; but if the engine should raise it, say 95 or 105 millims., while the cup yields 100 millims., then the valve will be either opened or closed by 5 millims., and the engine will be urged or checked, as the case may be, to such an extent as to make its revolutions coincide again absolutely with those of the regulating cup.

The driving power of the cup is limited by the weight, P, and may be considered as a constant regulating quantity (although it is derived indirectly from the engine); but whenever the valve has to be opened or closed, a resistance arises which goes either in diminution of or in addition to the weight, P, and the power of the cup must be such that its speed remains sufficiently uniform under the influence of these occasional variations.

By means of the automatic dip arrangement it would not be difficult to obtain perfect uniformity, notwithstanding these irregularities in the driving power; but

Fig. 9.



in the case of steam-engine governors this arrangement is dispensed with for the sake of a more immediate action upon the valve at the moment when a differential velocity arises. Supposing that the greatest amount of occasional variation of speed is to be 1 per cent., and that the dimensions of the cup are as follows:—

Diameter at upper rim, ... = 200 millims.
Diameter of rim above the liquid, ... = 200 millims.
Diameter of orifice at bottom of cup, . . . = 90 millims.

we find the available power of the instrument in the following manner:—

The normal speed of a cup of these dimensions is, according to our formula,

$$n = \frac{\sqrt{19600 \times 200\left(1 + \frac{45^2}{100^2 - {\cdot}293 \times 45^2}\right)}}{200\,\pi} = 3{\cdot}31 \text{ revolutions per second.}$$

The height to which the liquid is raised by rotation increases in the square ratio of the speed of rotation, the increase of height due to 1 per cent. increase of speed would therefore result from the following proportion:—

$$100\,v : 101\,v = \sqrt{h} : \sqrt{h'},$$

or the height due to the increased speed,

$$h' = 204 \text{ millims.},$$

that is to say, the liquid would be raised 4 millims. above the brim of the cup, which, being an unbalanced column, will produce an upward flow of the liquid in the cup, as expressed by the well-known formula,

$$v = \sqrt{2gh};$$

or h being in this case = 4 millims., we have

v = ·280 metre flow per second,

which, if multiplied by the least sectional area at the entrance into the cup = ·0057 square metre, gives the quantity of liquid

·280 metre × ·0057 square metre = ·0016 cubic metre,

or 1·6 litre of liquid raised 204 millims. high and projected with a velocity of

$\frac{204}{100}$ 3·31 × $2r\pi$ = 2·1 metres per second

over the brim of the cup, to be stopped by the stationary wings and once more accelerated by the rotating wings, which, being one-fifth more in diameter than the cup itself, impart to the liquid a velocity of

$\frac{6}{5}$ 2·1 = 2·5 metres per second.

These accelerations represent a power which, according to the formula

$$h = \frac{v^2}{2g},$$

is equal to the same liquid being lifted

for v = 2·1 metres . to ·225 metre height,
and for v = 2·5 . . to ·320 metre height,
In the cup it was lifted to ·200 metre height,

making a total lift . to ·745 metre height.

If the liquid employed is water, the 1·6 litre represents 1·6 kilogram., and the resistance produced by 1 per cent. increase of velocity is

1·6 × ·745 = 1·2 kilogrammetres per second,

which is equivalent to *forcing a valve rod or lever through one decimetre space in ten seconds against a resistance of* 120 *kilograms.*

This force exceeds by far what is usually required of a governor, and fits the new instrument for the accomplishment of objects which could hitherto not be attempted, such, for instance, as regulating the power of engines by the link motion or other variable expansion gear (whereby a considerable saving of fuel may be effected), or moving the gate of a water-wheel.

The most striking feature of this governor is, however, the rapidity with which a readjustment between power and load of an engine is effected; experiment has proved that *two-thirds of the total load upon an engine may be suddenly thrown off without producing any visible change in its rotation.* It must be borne in mind that the variation of 1 per cent., which was assumed in calculating the power of the instrument, applies only to the short period of ten seconds, when the readjustment of the valve is effected, after which the cup and with it the engine, returns to its normal rate of rotation; but an increase or decrease of speed of 1 per cent. during ten seconds is so small a total amount that it is not perceptible to the eye, and may be regarded as non-existing for practical purposes.

A uniform velocity of engines, such as is secured by this instrument, is of considerable practical importance in spinning, grinding corn, and other manufacturing operations, because it not only prevents breakages and irregularities in the quality of the work produced, but it enables manufacturers to attain to the maximum speed at which their work can be produced.

It has been shown that the rotating cup is not sensitive to tipping, a circumstance rendering the gyrometric governor also applicable to marine engines, which are much in need of a means for maintaining a uniform speed, particularly where the screw propeller is used, which, in being raised by waves above the water, allows the engine to fly off at a dangerous speed.

The gyrometric cup appears therefore to be equally applicable for maintaining powerful machinery at a nearly uniform velocity, and for obtaining the higher uniformity of rotation requisite for philosophical and telegraphic instruments.

SOCIETY OF ARTS.

THE "ALBERT GOLD MEDAL."

THE Council of the Society of Arts, under the presidency of his Royal Highness the Prince of Wales, has recently announced the award of the annual grant of the "Albert Medal" to William Fothergill Cooke, Esq., and Charles Wheatstone, F.R.S., for their joint labours in the introduction of the electric telegraph in the year 1837. The medal itself is a work of high art by Wyon, and bears one of the best likenesses of the lamented Prince that has been attained. In its execution and unusual dimensions it is in every respect worthy of the object to which it has been dedicated, and of the great and good Prince, whose memory, as the friend and patron of the society over which he presided for eighteen years, it is intended to preserve. The origin of the "Albert Medal" is but little known, and we extract from the Society of Arts journal for the 13th February, 1863, the following condensed account:—"At a general meeting of the society, specially convened, Sir Thomas Phillips in the chair, held on the 21st of March, 1862, the following resolution was passed unanimously:—'That, cordially approving of the address of condolence presented by the Council to the Queen, and also of the vote of 1000 guineas from the funds of the society to the National Memorial, the members of the Society of Arts, in this general meeting assembled, are anxious further to record their deep sense of the irreparable loss which the society, in common with the Queen and nation, has sustained by the most afflicting dispensation which has deprived it of its illustrious president, the Prince Consort; and this society, being under peculiar obligations to his Royal Highness, whose zealous devotion to its interests was unceasing during the eighteen years of his enlightened presidency, the members desire to testify their estimation of his great services and high qualities by having a special memorial for the society, and that the Council be requested to consider the most appropriate form of the memorial, and bring the matter before a meeting of the members at a fitting time.' The Council have had the foregoing resolution under their consideration, and they recommend that the memorial consist of a bust of his Royal Highness in marble, to be placed in a suitable manner in the great room of the society, and that the funds be raised by subscription amongst the members, and that any surplus funds not required for that object be applied in such manner as the subscribers may direct; and the Council are of opinion that a gold medal, to be called the Albert Medal, should be provided by the society, to be awarded by the Council, not oftener than once a year, 'for distinguished merit in promoting arts, manufactures, or commerce.' It would be a valuable medal—one worth striving for—not a small mark of honour; one which all might be proud to obtain. A medal to be denominated the Albert Medal would be as greatly coveted as the Copley Medal of the Royal Society. That was a medal which was open to men in all branches of science, and of all nations."

The propositions were carried with cordial unanimity.

The president of the Council, in his address to the last general meeting of the society, announces the grant of the "Albert Medal" for the present year, and recalls to the memory of its members the names of the great men whose public services and high merits have been recognized by the award of the "Albert Medal" since its foundation. We extract the following passages:—"The Albert Medal has this year been awarded to Mr. W. Fothergill Cook and Professor Charles Wheatstone, F.R.S., in recognition of their joint labours in establishing the first electric telegraph. It will be remembered that the first Albert Medal was awarded, in 1864, to Sir Rowland Hill, K.C.B., 'for his great services to arts, manufactures, and commerce, in the creation of the penny postage, and for his other reforms in the postal system of this country, the benefits of which have, however, not been confined to this country, but have extended over the civilized world.' The second medal was awarded, in 1865, to his Imperial Majesty the Emperor of the French, 'for distinguished merit in promoting, in many ways, by his personal exertions, the international progress of arts, manufactures, and commerce, the proofs of which are afforded by his judicious patronage of art, his enlightened commercial policy, and especially by the abolition of passports in favour of British subjects.' The third medal was awarded, 1866, to Professor Faraday, D.C.L., F.R.S., for 'discoveries in electricity, magnetism, and chemistry, which, in their relation to the industries of the world, have so largely promoted arts, manufactures, and commerce.' The Council think it right to remind the members of these several awards, in order to keep in their recollection the very high standard of merit which they are intended to mark. In making the award this year, the Council were placed in a somewhat peculiar position, inasmuch as by the terms upon which the medal was established they could only make one award, whilst the great object accomplished was due to the combined labours of two men. They felt, however, that so great a national work as the electric telegraph was especially worthy of reward by this society, and that the Albert Medal could not be more worthily bestowed than in recognition of the services of those to whom the introduction of the telegraph was due. The award having been made, they have directed that the medal be struck in duplicate, and a copy, with a suitable inscription, be presented to each of the above-named gentlemen. The Council feel assured that in selecting the introduction of telegraphy for the award of the Albert Medal, they will have the unanimous concurrence of the members of the society."

INSTITUTION OF CIVIL ENGINEERS.

THE Council of the Institution of Civil Engineers have awarded the following premiums for papers read at the meetings during the past session:—

1. A Telford Medal and a Telford Premium, in Books, to James T. Chance, M.A., Assoc. Inst. C.E., for his paper "On optical apparatus used in lighthouses."

2. A Telford Medal and a Telford Premium, in Books, to Edward Byrne, M. Inst. C.E., for his paper "Experiments on the removal of organic and inorganic substances in water."

3. A Telford Medal to George Biddell Airy, Astronomer Royal, Hon. M. Inst. C.E., for his paper "On the use of the suspension bridge with stiffened roadway for railway and other bridges of great span."

*4. A Watt Medal to Colonel Sir William Thomas Denison, K C.B., R.E., Assoc. Inst. C.E., for his paper on "The Suez canal."

5. A Watt Medal and a Telford Premium, in Books, to John Bourne, for his paper on "Ships of war."

*6. A Telford Premium, in Books, to Captain Henry Whatley Tyler, Assoc. Inst. C.E., for his paper "On the working of steep gradients and sharp curves on railways."

*7. A Telford Premium, in Books, to William Henry Preece, Assoc. Inst. C.E., for his paper "On the best means of communicating between the passengers, guards, and drivers of trains in motion."

*8. A Telford Premium, in Books, to William Alexander Brooks, M. Inst. C.E., for his paper on "The River Tyne."

9. The Manby Premium, in Books, to Charles Douglas Fox, M. Inst. C.E., for his paper "On light railways in Norway, India, and Queensland."

AERONAUTICAL SOCIETY OF GREAT BRITAIN.

WE have just before going to press received from the secretary of the Aeronautical Society, a bundle of the papers read before that body on the 15th ult. We regret that they are too late for insertion in the present part, and must unavoidably remain over until next issue.

* Have previously received Telford Medals.

MONTHLY NOTES.

THE PACIFIC RAILROAD.—It is reported that ten thousand labourers are kept employed in constructing the Pacific Railroad in California, 8000 of whom are Chinese, who work for thirty dollars a month and board themselves. These Chinese are said to be more tractable than white labourers, quite as productive, and 50 per cent. cheaper.

WICKERSHAM'S NAIL-MACHINE.—This machine, of which there is an example in the American section of the Paris Exhibition, produces a headed nail pointed like a chisel, and gradually tapered for its whole length. The usual plan has hitherto been to make the plate from which the nails are cut wide enough for the length of the nail, and then commence cutting from one end, and continuing the operation until it is all cut into nails, the machine cutting only one at a time. In the Wickersham machine a sheet of metal of from 20 to 25 inches is placed, and a series of nails cut from its edge at each stroke of the knives. To do this there are two series of cutters; viz., bed and moving cutters so arranged that by shifting the nailsheet laterally the distance equal to the length of two nails, each time a series of nails is cut, the nails being alternately reversed as to heads and points. The motions of the machine are only three; viz., the crank-motion of the cutter-jaw, the cam-motion for shifting the nailplate, and the feed-motion which moves the nail sheet towards the cutters each time it is shifted and a series of nails cut. In cutting half-inch patent brads or shoe-nails from a 20-inch plate, forty nails are cut at each stroke of the knives, or 160 per second, the machine driving the knives four times per second. Of patent brads from $\frac{3}{8}$ to 2 inches long, and shoe-nails of all sizes, one machine will cut 3600 lbs. per day. Of the larger size nails one machine will cut 5000 lbs., and ship-spikes $\frac{1}{4}$ to $\frac{3}{4}$ lbs. each, one machine will cut 25,000 lbs. per day of ten hours. This form of nail is said to be more easily driven, and to have a firmer hold on the wood than nails of the ordinary form.

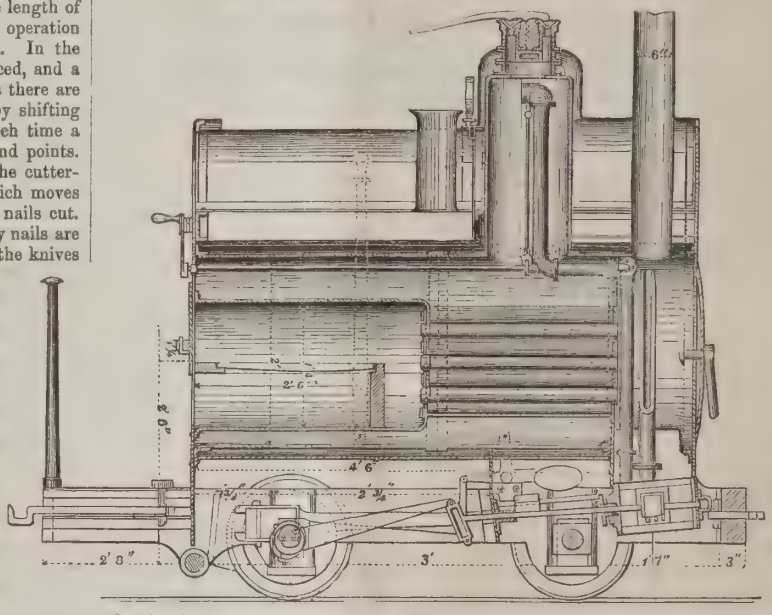
THE CHASSEPOT RIFLE.—This arm, which has come into such favour in France, has a calibre of 47-hundredths of an English inch, and its weight is 9½ lbs. It carries a sabre bayonet, and the length of the two is 6 feet 1½ inch. Its four shallow grooves turn from right to left, the reverse of the direction of other rifles. By means of a raisable sight-piece it carries with fair accuracy as far as 1100 yards, and the recoil is slight. Six shots a minute may be easily fired by it, and aim taken at the same time; without aiming, from eight to twelve shots may be fired. The aim is point blank up to 220 yards, and its accuracy up to 650 yards is said to be admirable. For some reason or other the French government has not exhibited a specimen of this rifle along with their other arms.

LOCOMOTIVES IN THE PARIS EXHIBITION.—In the London Exhibition of 1851 there were thirteen locomotives, of which only one was French and two Belgian. At the Paris Exhibition of 1855 there were twenty-one locomotives; nine of which were French, three Belgian, and two English, Austria and Germany contributing the remaining seven. At the London Exhibition of 1862 the locomotives were twenty-two in number, made up of thirteen English, four German, three French, one Belgian, and one Italian. In the present Exhibition are to be seen no fewer than thirty-three locomotives, contributed thus: Fourteen by France, eight by Austria and Germany, five by England, five by Belgium, and one by the United States; Russia, Spain, and Italy being unrepresented. It appears that, notwithstanding the paucity of locomotives sent from the United Kingdom, no other country possesses so many establishments for the manufacture of locomotives. In England and Scotland there are twenty-eight of these establishments, and, in addition, nine railway companies supply their own requirements. The total annual production of locomotives in Great Britain is supposed to be about 1500. In Germany, including Austria, there are ten of such establishments, the capitals of Berlin, Vienna, Munich, Carlsruhe, and Hanover having each one. The little kingdom of Belgium possesses nine locomotive manufactories, and France eight, besides six establishments belonging to railway companies. These are sufficient to turn out annually 1000 locomotives. Upon French railways, which have an extent of about 8100 miles, there are about 3500 locomotives.

SALISBURY CATHEDRAL.—The capstone of this Cathedral spire, immediately under the vane, having been discovered to be in a very decayed state, workmen are now engaged in its repair. At so lofty an altitude, upwards of 400 feet, a work of this sort is not an easy matter; and it has, therefore, become necessary, in order to enable them to do it effectually, to surround that part of the spire near the weather door with a strong platform, from which a series of five others have been erected at certain distances above one another, the last being at the summit. The ascent from the weather door to the top is accomplished on the outside by means of about twenty iron handles firmly fixed in the spire. Surrounded by scaffolding on the extreme top, the spire now presents a very curious appearance.

APPLICATIONS OF PAPER.—The uses of compressed vegetable pulp, or artificial wood, already very numerous, are multiplying. Among its good qualities, its low conductivity is important, and but imperfectly appreciated. Many have seen, and verified by experiment, the statement that the warmest kind of bed comforter can be made by pasting old newspapers together. Something in this line might be made a valuable new article of manufacture. Cisterns and water pipes of prepared paper, with a sufficient ingredient or else coating of insoluble substance, have been brought into use in England for their remarkable resistance to the penetration of frost, or, more accurately, their remarkable retention of the heat of their contents. It is stated that at the Albert Works, England, there was in the open yard a large brick tank containing several tuns of water, the ice in which was several inches thick during the severe cold of the past winter. By the side of this was another tank, made of paper boards, the water in which was not the least frozen. Some iron pipes which supplied water to the boiler of the engine-house from a large cistern burst in several places in consequence of the freezing of the water which they contained. Some paper pipes, on the other hand, filled with water, and which had been exposed to the snow on the ground, kept the water from freezing. In a model house or hut, made of paper, some water in open bowls and pails did not freeze, though outside the building there were large masses of ice. The manufacture of paper pails has been initiated in this country, and we see no reason why they should not make a superior article. Sugar moulds are now made of paper by the same parties (American Papier Maché Co., Green Point, L.I.); and Messrs. Havemeyer & Elder, the noted sugar refiners, speak in the highest terms of a lot of 4000 of these moulds, which they have used for a year, preferring them to iron. An all-paper hat is coming into market, as we hear. Paper substitutes for starched linen are in common use; but what shall we say to paper shirts, drawers, and hose, for which a patent has been taken out? Is the whole series of metallic ages—silver, gold, brass, and iron—to wind up in an age of rags?—*Paper Trade Review.*

THE CREWE LOCOMOTIVE "TINY."—The accompanying woodcut illustrates



a longitudinal section of one of the small engines employed at Crewe Works for the purpose of transporting to various parts of the works the details of the locomotive engines as they proceed to go through their different stages of preparation in the several shops and yards. These engines were designed by and constructed under Mr. Ramsbottom's supervision in 1862, since which time they have been at work. Rails are laid down to enable them to traverse throughout the works. The section is so complete that we need not supplement it with further explanation.

THE PARIS EXHIBITION.—The British Commissioners have engaged a large hall in the outer circle of the British section of the Exhibition building for the convenience of British workmen visiting the Exhibition. They are admitted free on showing their excursion or weekly tickets, or on producing the signed card of any exhibitor, manufacturer, clergyman, or municipal or other authority of the kingdom. The tables are supplied with English newspapers; and information of various kinds relating to Paris, the railways, &c., is to be obtained there. There are small tables supplied with pens, ink, and paper, for those who wish to write. The secretary is able to give introduction to manufactories and establishments of various kinds, to the number of 120. The catalogues to the British section can be obtained there at half-price. The hours are from nine to five. This hall will probably be very useful to many workmen.

WHAT MAKES IRON FIBROUS?—When Mr. Bessemer manufactured wrought iron from cast, by blowing air into the molten metal, it was objected to the product that it had no fibre, as common puddled iron had, and that iron without fibre must necessarily be weak. In this inference—which was wholly theoretical—we did not concur, and the question then arose, What does fibrous iron really mean? When the particles of wrought iron are brought to a high temperature, without the presence of any intervening material, they cohere in every direction, and the iron is not fibrous. But when slag is intermingled, as in common puddled iron is the case, there are intervening layers of cinder, which, when the iron is passed through the rolls, are not wholly expelled, but are only greatly attenuated; and as these planes are then very numerous, and pass in every longitudinal direction, they prevent to some extent the lateral adhesion of the particles, which, however, adhere end to end, and a fibrous iron is thus produced. It is now well known that homogeneous iron is much stronger than fibrous iron. But at the beginning of the manufacture, fibre was accounted as necessary in iron as in ropes or thread—a theory resulting merely from the accident of the production of fibre by the modes of manufacture then exclusively employed. In the case of iron produced by the common process, any bubble or vacuity in the metal becomes filled with slag, which hinders the sides from being effectually welded under the hammer. But in the Bessemer iron, as the slag is absent, the sides of the bubble cohere when the ingot is subjected to pressure while still hot. It is better to hammer the ingots while still hot, after having being poured, than to allow them to cool and to heat them afterwards. For in the one case the heart of the ingot is the hottest part, and in the other the coldest.—*Engineering.*

FROM LONDON TO LIVERPOOL IN FOUR HOURS AND A QUARTER.—It is proposed, on the completion of the bridge and viaduct at Runcorn Gap, which will save about ten miles in the distance between London and Liverpool, to run express trains which will surpass anything yet obtained in railway travelling in this or any other country. The whole distance, over 200 miles, will be run without a single stoppage, and the time occupied will be about four and a quarter hours. The

engines, which are of magnificent dimensions and of great power, will take up water at Rugby while in motion, as is now the case with the engines of the Irish mail. The carriages will be built somewhat upon the American principle, with passage up the centre, and they will be provided with retiring rooms for passengers. Arrangements will also be made for the supply of refreshments on the journey.—*Railway News.*

APPLICATIONS FOR

PROVISIONAL PROTECTION FOR INVENTIONS

UNDER THE PATENT LAW AMENDMENT ACT.

☞ When the city or town is not mentioned, London is to be understood.

13th June, 1867.

1729 T. S. Prideaux, Piccadilly—Improving wine
1730 E. T. Hughes, Chancery Lane—Brushes.—A com.
1731 A. C. Lion, Paris—Chains, bracelets, necklaces
1732 J. Holmes, Wapping Road—Bricks and tiles
1733 T. B. Baker and L. Lindley, Sherwood Street—Treating lace
1734 R. H. Barton, Chorley—Preparation of cotton
1735 J. Glover, Sekforde Street—Furnaces
1736 S. Hancock, Friar Lane—Signalling in railway trains

14th June, 1867.

1737 W. King, Woodside—Signalling on railway trains
1738 C. Askew, Charles Street—Refrigerators
1739 S. Tuddenham, Lower Marsh—Gates, railings, and standards
1740 D. E. M'Mahon, Aldershot—Saddles
1741 H. H. Bryant, Boston—Fireproof safes
1742 S. E. Crow, Stratford—Furnaces
1743 G. Ker, Gabriel's Hill—Drying fabrics

15th June, 1867.

1744 J. Fletcher and W. Carr, Blackburn—Sizing yarns
1745 J. Quin, Fulham Road—Fire escape
1746 T. Walker, Birmingham—Spring hooks
1747 J. Onions, Devon Place—Iron and steel
1748 G. M'Kenzie, Glasgow—Illuminating gas
1749 C. Sadler, Chiddingfold—Furnaces
1750 R. Beard, Oxford Street—Galvanic batteries
1751 A. M. Clark, Chancery Lane—Cooling beverages.—A com.
1752 W. E. Newton, Chancery Lane—Pulp for paper
1753 G. Allix, Saint Heliers—Hoisting machines
1754 C. Erba, Milan—Leather tanning
1755 C. and S. A. Varley, London—Telegraphs
1756 W. R. Lake, Chancery Lane—Saw teeth.—A com
1757 G. Clark, Arundel Street—Guns and projectiles
1758 L. S. Crossley and J. Sunderland, Halifax—Oiling wool

17th June, 1867.

1759 R. W. Barnes, Manchester—Metallic pens
1760 J. Meiklejohn, Dalkeith—Hoisting apparatus
1761 J. Fletcher and W. Carr, Blackburn—Sewing machines
1762 C. D. Abel, Chancery Lane—Retarding motion of vehicles.—A com.
1763 J. H. Johnson, Lincoln's Inn Fields—Wood screws.—A com.
1764 W. R. Lake, Chancery Lane—Railway carriages.—A com.
1765 J. Welch, Redditch—Swivels for fishing tackle
1766 J. E. Boyce and R. Harrington, Birmingham—Umbrellas
1767 F. B. Miller, Sidney—Toughening gold
1768 J. G. Lloyd, Blaina—Compressing air
1769 J. T. Bousfield, Brixton—Time keepers
1770 M. Gray, Islington—Telegraphic conductors
1771 M. Gray, Islington, and L. Gibson, Silvertown—Coating telegraphic wires
1772 M. Gray, Islington—Telegraphic conductors
1773 W. Cooke, Liverpool—Registering the number of passengers carried in vehicles
1774 D. Sowden and R. C. Stephenson, Bradford—Looms
1775 Sir T. Tancred, Pangbourne—Bee hives
1776 P. Welch, New York—Dressing types

18th June, 1867.

1777 W. Fairley, Loughor—Preventing over-winding in mine shafts
1778 J. M. Frost, St. Leonard's-on-Sea—Raising sunken vessels
1779 C. D. Abel, Chancery Lane—Watches and clocks.—A com.
1780 R. Bodmer, Newport—Securing nuts of bolts
1781 J. Edwards, Wednesbury—Lifts or cages for minerals
1782 T. Brown, Newgate Street—Holding and lifting plates and dishes
1783 J. G. Jones, Blaina—Getting coals and other minerals
1784 W. S. Thomson, Cheapside—Heating and annealing furnaces
1785 J. Lang, Cockspur Street—Fire-arms

19th June, 1867.

1786 D. Jones, Birmingham—Coal buckets
1787 T. W. Waide, Rotherham—Obtaining motive power
1788 L. Simon, Nottingham—Bronzing
1789 M. Lyons, Birmingham—Frames for looking glasses
1790 J. Coppard, Islington—Doors and windows
1791 E. W. Hughes, Westminster, and T. H. Head, London—Rotary engines
1792 A. L. Panter, Gray's Inn Road—Seats for children
1793 H. C. Hurry, Hereford—Stop blocks and buffer stops
1794 W. M'Lellan, Glasgow—Railway buffers
1795 J. H. Johnson, Lincoln's Inn Fields—Yarns.—A com.
1796 J. E. Whiting, Westminster—Castors

20th June, 1867.

1797 D. Jones, Birmingham—Handles for hollow ware
1798 A. M. Clark, Chancery Lane—Sewing leather or strong material
1799 T. Wilson, Birmingham—Movable spanners
1800 T. G. N. Perrett, Somerton—Blind pulleys
1801 L. Sterne, Old Broad Street—Chucks for boring tools
1802 C. Stuart, Glasgow—Wrenches
1803 H. K. York, Cardiff—Steel
1804 H. G. B. Rober, Braunschweig—Safety box slides
1805 J. Ward, Leicester Square, and F. Dressler, Oxford Street—Easy chairs
1806 J. W. Cochrane, Chancery Lane—Projectiles and cartridges
1807 W. Clarke Nottingham—Ornamental fabrics

21st June, 1867.

1808 J. W. Perkins, Great St. Helen's—Stills
1809 W. Robertson and C. J. Waddell, Manchester—Carding engines
1810 H. Oram, Bury—Sewing machines
1811 B. Browne, King William Street—Camps.—A com.
1812 J. Gardner, Newington—Couches
1813 J. Powis and J. S. James, Lambeth—Tenon cutting machines
1814 W. Bellhouse, Rochdale—Furnaces
1815 A. M. Clark, Chancery Lane—Measuring horses' feet.—A com.
1816 F. C. Hennet and D. Spink, Bridgewater—Raising and lowering weights
1817 B. and T. Ford, Wednesfield Heath—Water tuyeres
1818 W. Price, Birmingham—Dies
1819 G. Dickie, Kilwinning—Illuminating gas
1820 G. Simpson, Whitburn—Retorts
1821 T. Reddicliffe, Llanidloes—Buckets
1822 E. M'Clintock, Langham Hotel—Motive power engines

22nd June, 1867.

1823 J. Onslow and F. Northall—Water tuyeres
1824 O. R. Chase, Montague Street—Feed water regulators.—A com.
1825 R. W. Morrell, Bradford—Dyeing fabrics
1826 A. M. Clark, Chancery Lane—Nippers.—A com.
1827 S. Holman-Laurence, Pountney Lane—Pumps
1828 T. Wilson and W. Hall, Newcastle-upon-Tyne—Raising and forcing water
1829 J. Surridge, Cogan—Anchors
1830 S. Hall and W. H. Parsons, Swansea—Moulding fuel
1831 J. L. V. le Marquis de Cosentino, Charing Cross Hotel—Motive power

24th June, 1867.

1832 J. H. Rearns, Bennet's Hill—Blotting pads
1833 J. Birch, Newton Heath—Casting steel
1834 T. Rafferty and J. H. Storey, Manchester—Moving metal pipes
1835 E. Leahy, Cardingston Street—Cartridge cases
1836 J. K. Field, Lambeth—Candles
1837 E. P. Gleason, New York—Gas burner
1838 L. C. F. Clerc, Saint Mary Axe—Lamp burners
1839 W. E. Newton, Chancery Lane—Governors for marine engines.—A com.
1840 R. Capper, Mincing Lane, and J. Read, Deal—Signal lights
1841 H. Rushton, Barnsbury—Artificial hair
1842 H. R. J. Denton, Wolverhampton—Hay machines

25th June, 1867.

1843 T. Pebardy, Saint Paul's Road—Surgical appendages
1844 J. Wilkinson and W. Grimshaw, Sheffield—Watches
1845 J. Webster, Birmingham—Paint
1846 T. Crow, West Ham—Illuminating gas
1847 J. E. Whiting, Westminster—Transmitting power
1848 T. Hook, Ekenas—Furling topsails
1849 A. Aitchison and T. South, Surrey—Illuminating gas
1850 L. Brunetti, Rovigno—Preserving animal substances from decay
1851 W. T. Watts and D. J. Fleetwood, Birmingham—Hollow vessels and dishes
1852 J. Buckingham, London—Tools for opening metallic cases
1853 H. Veillon, Toulouse—Hot-air ovens
1854 G. Alston, Glasgow—Consuming smoke of furnaces
1855 W. Cooke, Paddington—Hoisting apparatus

26th June, 1867.

1856 M. T. Maury, Belsize Square—Protecting cables
1857 T. Taylor, Wellington Row—Implements for playing games
1858 J. Human, Euston Road—Fire-arms
1859 R. Eadie, Newcastle-upon-Tyne—Axles
1860 W. E. Newton, Chancery Lane—Filtering apparatus.—A com.
1861 R. P. Forlong, Bristol—Consuming smoke
1862 W. B. Gray and S. G. Sinclair, Whiteabby—Spinning machine
1863 W. R. Lake, Chancery Lane—Churns.—A com.
1864 W. R. Lake, Chancery Lane—Cotton gins.—A com.
1865 A. C. F. Franklin, Bayswater—Steam-engines

27th June, 1867.

1866 E. Whele, Aston—Cutting soap
1867 J. G. Rowe, Westminster—Railway signals
1868 W. E. Gedge, Wellington Street—Raising running waters.—A com.
1869 J. M'Ewen, Glasgow—Roll tobacco
1870 J. Gabbott, Blackburn—Looms
1871 W. Bullough, Blackburn—Looms
1872 J. and J. Cash, Coventry—Winding tapes
1873 E. Farrington, Paris—Fire-arms
1874 C. E. Brooman, Fleet Street—'Jupon.'—A com.
1875 W. E. Newton, Chancery Lane—Iced beverages
1876 M. S. Taylor, Littleborough—Tuyeres
1877 W. Hodgson, Bradford—'Screw gill boxes'
1878 C. J. Pownall, Twickenham—Communicating intelligence
1879 W. R. Lake, Chancery Lane—Self-detaching couplings.—A com.
1880 W. R. Lake, Chancery Lane—Ties and bands.—A com.
1881 J. R. Cooper, Birmingham—Fire-arms
1882 W. Davis, Gainford—Securing envelopes

28th June, 1867.

1883 L. B. Elliot, Maulton—Mowing machines
1884 W. Marshal, Nottingham—Bedsteads
1885 J. H. Viton, Paris—Adjusting paper linings
1886 C. O. Heyl, Berlin—Sulphuret
1887 C. O. Heyl, Berlin—Scouring wool
1888 J. C. Sellars, Birkenhead—Utilizing waste material
1889 E. J. Hughes, Manchester—Blankets.—A com.
1890 A. M. Clark, Chancery Lane—Presses.—A com.
1891 G. R. Geyelin, Argyle Square—Folding wire netting
1892 C. Brown, Glasgow—Motive power engines
1893 H. A. Lyman, Cheapside—Ladies' skirts.—A com.
1894 J. G. Tongue, Chancery Lane—Wrenches.—A com.
1895 J. and T. Anderson, Bradford—Harness of engines
1896 J. Holroyd and W. Fieldhouse, York—Twisting machinery

29th June, 1867.

1897 C. O. Heyl, Berlin—Extracting oil from cotton
1898 P. Zarowbine, St. Petersburg—Pumps
1899 P. Smith, Philpot Lane—Corking bottles.—A com.
1900 A. M. Fell, West Calder—Purifying compound for sheep's fleeces
1901 A. M. Fell, West Calder—Batching jute
1902 A. Hodge, Glasgow—Door handles
1903 H. J. Cox, Birmingham—Carriage bodies
1904 S. R. and W. Trulock, Dublin—Fire-arms
1905 W. H. Richardson, Glasgow—Iron and steel
1906 A. Stewart, Hamilton—Textile fabrics
1907 J. J. Lane, Old Ford Road—Tapers
1908 C. C. Dubrulle, Lille—Lamps
1909 J. Conlong, Blackburn—Combs

1910 C. Petit, Brussels—Lamps
1911 E. Sephton, Liverpool—Workman's dwellings
1912 E. Simmons, Stoke Newington—Propellers
1913 C. E. Brooman, Fleet Street—Artificial flowers.—A com.
1914 G. Rees, Holloway—Glass

1st *July*, 1867.

1915 J. G. N. Alleyne, Alfreton—Clocks
1916 J. Chaudron, Brussels—Sinking wells
1917 F. T. Hubert and H. D. G. Truscott, Walworth—Telegraphic machines
1918 F. T. Pollard, Holbeck—Bench hook
1919 P. Ironside, Westminster—Blinds

2nd *July*, 1867.

1920 J. R. Burn, Kirby Street—Cutting paper
1921 W. Duce, York—Stopping bottles
1922 W. Steven and A. Robertson, Glasgow—Brickmaking machines
1923 J. Greenhalgh, Oldham—Cleaning cotton
1924 G. A. F. Fowke, Westminster—Preventing the fouling of ships
1925 T. and J. Wood, Newton Heath—Printing yarn
1926 A. M. Clark, Chancery Lane—Breech-loading ordnance.—A com.
1927 J. Sturgeon, Bolton-le-Moors—Getting coal
1928 A. Schwartz, Berlin—Lubricators
1929 T. Young, Philadelphia—Buttons
1930 G. Gordon, California—Drying moist substances

3rd *July*, 1867.

1931 J. Somerville and R. Elsdon, Maidstone—Purifying gas
1932 J. Elce and P. Williams, Manchester—Spinning
1933 W. R. Lake, Chancery Lane—Manufacturing cordage.—A com.
1934 T. R. Aikman, London—Fire-arms
1935 J. M'Ribbin, Mount Pottinger—Filling and drawing liquids
1936 H. and D. Davy, Sheffield—Centrifugal governors
1937 W. Galloway and G. Plant, Manchester—Welded tubes
1938 D. P. Morison, Durham—Safety lamps
1939 T. Borlase, Redruth—Grinding metallic ores
1940 W. S. Scott and W. H. Steel, Surrey—Valves
1941 R. Shaw, Barrow-in-Furness—Motive power engines
1942 J. H. Johnson, Lincoln's Inn Fields—Preserving butter.—A com.
1943 H. Clarke, Chancery Lane—Propelling vessels
1944 D. Davy, Sheffield—Steam hammers
1945 W. Thompson, Dublin—Mouthpieces for cigars
1946 J. Salmon, Manchester, and G. W. Hick, Leeds—Ruling paper
1947 F. Leonardt, Birmingham—Lamps.—A com.
1948 J. M'Adams, Brooklyn—Printing
1949 W. E. Newton, Chancery Lane—Soda water.—A com.
1950 A. E. Herrmann, Mincing Lane—Lubricating compound.—A com.
1951 E. M. Brown, Bury St. Edmunds—Carrying umbrellas

4th *July*, 1867.

1952 R. Hellard, Taunton—Reaping machines
1953 T. Welton, Grafton Street—Revolving shutters
1954 J. Ferreyt, Ixelles—Organs
1955 T. and T. Vicars and J. Smith, Liverpool—Self-feeding furnaces
1956 P. F. Tranchat, Paris—Cutting fraises
1957 A. A. Champion, Clerkenwell—Chronographs
1958 H. Clarke, Chancery Lane—Propelling vessels
1959 T. Brandy, St. John's Terrace—Switches and signals
1960 J. Bolton, Dorset—Holders for croquet balls
1961 W. Day, Westwood Park—Sheathing ships
1962 W. E. Newton, Chancery Lane—Fire-arms.—A com.
1963 A. V. Newton, Chancery Lane—Ship's propellers.—A com.
1964 J. Pick, Falcon Square—Scarfs
1965 M. Henry, Fleet Street—Hoisting apparatus
1966 H. Ruddick, Chelsea—Steam engines
1967 W. R. Lake, Chancery Lane—Illuminating gas

5th *July*, 1867.

1968 E. O. Greening and J. Aitkenson, Manchester—Washing machine
1969 P. L. T. E. Roussel, Boulogne-sur-Mer—Writing stall
1970 C. D. Abel, Chancery Lane—Elastic straps.—A com.
1971 J. Macnaughton, Edinburgh—Fire-arms
1972 H. C. Carver, Manchester—Hoop-iron fastenings.—A com.
1973 W. R. Lake, Chancery Lane—Metal tubes.—A com.

6th *July*, 1867.

1974 W. C. Church, Manchester—Motive engines
1975 F. Andrew and L. Clarkson, Harpurhey—Printing fabrics
1976 W. R. Gorst, Liverpool—Wheeled vehicles
1977 R. Tiernan, Liverpool—Tobacco pipes
1978 T. C. Thomas, Banbury—Water-closet fittings
1979 W. E. Newton, Chancery Lane—Constructing railways.—A com.
1980 T. Morgan, Stockton-on-Tees—Furnaces
1981 H. B. Woodcock, Low Moor—Tyres
1982 T. Craddock, Kilburn—Flying apparatus
1983 W. Harris, Brecon—Converting sawdust into charcoal
1984 W. Archer, Birmingham—Rotary engines
1985 C. Toft, Handsworth—Liquor frames
1986 J. C. Major, Wolverhampton—Furnaces
1987 N. Thompson, Abbey Gardens—Connecting tubes
1988 G. Severn, Hampstead Road—Cooling worts

8th *July*, 1867.

1989 J. Whitford, Liverpool—Ice-making apparatus
1990 J. Capper, Waterloo—Chimney tops
1991 J. G. Tongue, Chancery Lane—Training plants
1992 J. M. M'George, Commune Newry, and A. Paul, Liverpool—Plug valve
1993 J. Johnson and E. Shinn, Manchester, and G. Ragg, Liverpool—Signalling apparatus
1994 J. M. Loere, Notting Hill—Preparing canvas and linen
1995 J. Shanks, Arbroath—Mowing machine
1996 N. Tasker, Andover—Thrashing machines
1997 A. Mather, Edinburgh—Cleaning grain
1998 A. Turner, Leicester, and W. Hemsley, Melbourne—Elastic fabrics
1999 N. Clayton and J. Shuttleworth, Lincoln—Road locomotives
2000 M. P. W. Boulton, Tew Park—Engines
2001 N. Clayton and J. Shuttleworth, Lincoln—Slide valves
2002 W. Andrews, Melkshand—Hay-making machines

9th *July*, 1867.

2003 J. M'F. Gray, Liverpool—Marine engines
2004 J. J. Buckley, Chelsea, and C. Hook, Maidstone—Gas
2005 W. E. Gedge, Wellington Street—A regulating level.—A com.
2006 G. Gabillon, Paris—Preserving paper
2007 W. Avery, Redditch—Boxes for needles
2008 A. Shanks, Westminster—Rivets
2009 J. Credland, Manchester—Arranging flues
2010 E. and F. Cook, Carnaby Street—Crushing bones
2011 W. E. Newton, Chancery Lane—Purifying alcohol.—A com.
2012 R. Smith, Islington—A coating for ships
2013 W. R. Lake, Chancery Lane—Manufacturing cards.—A com.
2014 W. Wood, Pontefract—Manufacturing carpets
2015 W. S. Andrews, Abbey Road—Telegraphic communications
2016 W. S. Andrews, Abbey Road—Telegraphic communications
2017 H. English and J. Fardon, Leicester—Shuttles

10th *July*, 1867.

2018 J. E. Whiting, Westminster—Suspension bridges
2019 J. S. Hood, Vivian Road—Life buoys
2020 D. and J. Collinge, Oldham—Looms
2021 H. B. Tox, Oxton, and J. T. Hall, Liverpool—Stoppers for bottles
2022 F. Holmes, Plumstead—Pumps
2023 J. N. Paxman and M. Davey, Colchester—Drying grain
2024 G. Davies, Lincoln's Inn—Metallic eye for laces
2025 W. Heyes and W. Bevan, Dunkinfield—A self-acting buckle
2026 W. L. Wise, Westminster—Crossings.—A com.
2027 W. E. Newton, Chancery Lane—Boring apparatus.—A com.
2028 G. R. B. Arnott, Gloucester—Making bricks
2029 A. H. Brandon, Paris—Wood-planing machines.—A com.
2030 A. H. Brandon, Paris—Saw machine.—A com.

11th *July*, 1867.

2031 J. Stirk and H. Bycroft, Burton-on-Trent—Refrigerators
2032 J. B. Fraser, Kenilworth—Machinery for manufacturing watches
2033 J. S. Henderson and J. Macintosh, Aberdeen—Manufacturing metallic cases
2034 J. H. Johnson, Lincoln's Inn Fields—Sugar.—A com.
2035 J. H. Johnson, Lincoln's Inn Fields—Boots and shoes.—A com.
2036 K. J. Winslow, Twickenham—Conveying rotatory motion
2037 B. Hunt, Culford—Bearings for machinery
2038 W. E. Newton, Chancery Lane—Construction of the way of railways.—A com.
2039 J. S. Burke and B. Burleigh, Westminster—Sub-aqueous works
2040 E. Hohenbruck, Vienna—Fire-arms

12th *July*, 1867.

2041 R. A. Kennedy, Alderley Edge—Doors and windows
2042 J. Nelson, Sunderland—Casting fire-bars
2043 J. B. E. G. Perrin, Paris—Smoke consuming apparatus
2044 E. H. Bernier, Paris—Hoisting apparatus
2045 T. Wilkins, Adelphi—Producing light or heat
2046 J. Hargreaves, Appleton-within-Widnes—Steel
2047 W. B. Haigh, Oldham—Tenoning wood
2048 J. Kellett, Leeds—Preventing smoke in furnaces
2049 G. Sinclair, Leith—Steam boilers
2050 C. T. Higginbotham, Glasgow—Furnaces
2051 J. H. Johnson, Lincoln's Inn Fields—Cutting meat.—A com.
2052 A. M. Clark, Chancery Lane—Life boats.—A com.
2053 J. Pasfield, Sedgley—Safety valves
2054 D. M. Henderson, Smethwick—Lanterns
2055 A. E. Herrmann, Mincing Lane—Igniting fires.—A com.
2056 G. T. Bousfield, Brixton—Corsets
2057 J. Laing, Sunderland—Fastening wood to iron
2058 E. B. Bigelow, Boston—Looms

13th *July*, 1867.

2059 P. M. A. Laurent, St. Nazaire Town—Compasses
2060 R. Sims and J. Prest, Bedford—'Horse rakes'
2061 J. Walker, Wolverhampton—Clips
2062 W. Drury, Surrey, and C. Westrup, Middlesex—Indicating names on doors
2063 T. Berney, Bracon Hall—Bending plates of metal
2064 H. Bell, Birmingham—Heel tips
2065 H. Fletcher, Liverpool—Artificial fuel
2066 H. Duke, Liverpool—Furling ship's sails
2067 E. T. Hughes, Chancery Lane—Self-acting vent peg.—A com.
2068 J. C. Ramsden, Bradford—Reeds and healds
2069 J. Scott, Oxford Street—Fire-escapes
2070 J. G. Tongue, Chancery Lane—Ruling apparatus.—A com.
2071 J. L. Norton, Ludgate Hill—Drying grain

15th *July*, 1867.

2072 J. Baggs, High Holborn—Washing basins
2073 T. Wrigley, Todmorden—'Pulley and chain'
2074 G. Boehm, Offenbach—The combination of a bottle and compass
2075 F. D. Nuttall, St. Helens—Furnaces
2076 J. M. Hetherington, Manchester, and R. W. Pitfield, Bolton—Spinning cotton
2077 J. Briere, Brussels—Self-acting condenser
2078 A. B. Ibbotson, Sheffield—Ventilating carriages.—A com.
2079 T. Redwood, Russell Square—Preserving meat
2080 J. T. Skinner, Keele, Newcastle—Signalling on railway trains
2081 J. Fleming, Glasgow—Raising malt liquor

16th *July*, 1867.

2082 F. B. Vallance, Regent's Park—Lamps
2083 H. G. Dunn, North Peckham—Saving life from fire
2084 J. Fraser, Liverpool—Printing
2085 G. W. Hayes, Hemel Hempstead—Making paper
2086 J. Mannock, Oldham—Scrapers
2087 W. M'Andrew, King William Street—Ginning cotton.—A com.
2088 T. Pirie, Nether Kinmundy—Agricultural implements
2089 H. A. Bonneville, Paris—Railroads.—A com.
2090 H. A. Bonneville, Paris—Brushes.—A com.

17th *July*, 1867

2091 T. W. R. Webster, Kinnettles—Loading cartridges
2092 T. Archer, Gateshead-on-Tyne—Pulverizing ores
2093 C. M. Tate, Claremont Square—Button fastenings
2094 G. Weedon, King Street—Knife-cleaning machines
2095 J. Schofield and J. C. Dawson, Leeds—Drying barley
2096 A. de Smet, Ghent—Spindles
2097 J. Slater, Bankfoot—Steam generators
2098 G. H. Daw, Threadneedle Street—Cartridge punches.—A com.
2099 S. C. Lister, Bradford—Consuming smoke
2100 J. H. Johnson, Lincoln's Inn Fields—Purifying oil.—A com.
2101 J. R. Swann, Edinburgh—Steam engines
2102 C. Klug, Regent Street—Chocolate
2103 W. R. Lake, Chancery Lane—Looms.—A com.

18th *July*, 1867.

2104 N. J. O. Stubber, Claverton Street—Flax and hemp
2105 W. Barningham and J. Thompson, Pendleton—Bending and punching metal
2106 A. Morton, Glasgow—Induction of fluids
2107 T. D. Walker, Longwood—Heating water
2108 J. J. and T. Palmer, Harborne—Spanners
2109 W. Warden, Gateshead-on-Tyne—Obliterating stamps
2110 G. T. Bousfield, Brixton—Cooking apparatus.—A com.
2111 J. J. and E. Harrison, Manchester—Looms
2112 R. T. Bradbury and T. Bottomley, Saddleworth—Carding engines
2113 A. Paton, Leeds—Printing machines

ON THE WAR MATERIAL EXHIBITED AT PARIS.

To give anything like a complete description of the war material in its most enlarged sense, exhibited at Paris, would be to write a largely sized volume. We should have nearly all the apparatus of the land armaments of Europe, as well as that of its fleets—all the contrivances of attack, as well as those of defence—to describe. We purpose here giving our readers a sketch of a few of the more salient objects shown by the several governments, and choosing those which are of interest to the mechanician and engineer, rather than those most important to the scientific soldier.

A good deal of disappointment has been expressed that France has not presented herself more prominently in this department. She certainly has not done so on a scale commensurate with the grandeur of her Exhibition in the machinery zone; but it is not necessary that we should attribute this difference to any unworthy motive, nor suppose, as has been hinted, that France, having induced the other great military powers to exhibit their weapons and defences, has taken good care to preserve her own as secret as before. In reality there probably was much less in the way of novel or scientific war appliances, which were not previously well known, in possession of France than was commonly supposed. It is upon her army, upon the men, their outfit, their discipline and readiness, upon the perfection of the thinking and living trained instrument, much more than upon the exaggerated character or exceptional power of her weapons, that France relies, and justly; and she probably had much less of the latter to show than was popularly anticipated. Perhaps she has kept back a good deal that is still in the category of novelties proposed, but yet to be tried in actual warfare; but so have we, and so have all the other powers. England has placed the limitation upon herself of only exhibiting within her shed objects already actually adopted into the service, and therefore in one sense of no novelty.

Had the museum of the Ordnance Select Committee at Woolwich and its archives and portfolios been ransacked, and the cream even of the innumerable inventions or proposals which have been brought before it during the last twelve years only fairly put before the world, we doubt if any nation would have been able to have displayed an equal amount of mind and inventive ability applied to the instruments of war. But such a display would have been unwise, unfair in some cases, and scarcely practicable, so that the limitation decided upon—viz., to exhibit only what has been actually adopted into the service—seems unexceptionable. Even with this limitation the British military display is the largest and most complete and detailed exhibited by any nation.

The artillery shown by England also is certainly the most ponderous and powerful in the Champ de Mars, as well as the most workmanlike (as respects those heavy guns at least); but to one who thoughtfully compares these tremendous instruments with the means we possess, or at least have up to now developed, for obtaining in time of need an adequate *personelle* for our armoury, the reflection is inevitable, that in our military display the mechanical genius and resource of England is more obvious than her actual military power; while exactly the opposite is the result of the examination of the display made of her weapons by France, and of her army itself, in the several grand reviews which have taken place during the last three months in or near Paris. In respect of the scientific elegance of method shown in some of her military instruments, Austria appears to stand superior to any of the other continental powers, unless, indeed, we make one exception in favour of France—namely, the elegant apparatus of Captain E. Schultz, for determining the law of velocity of projectiles during their transit along the chase of the gun; of which more anon.

Prussia, though it is but fair to say not the Prussian government, avowedly at least, goes in for gross size in the huge Krupp steel breech-loading cannon, of which so much has been already said, which is shown in the machinery zone. Of this enormous gun, the calibre of which is unequalled by any other in the Exhibition, as is also its total weight, we shall say no more than this:—While it gives evidence of unequalled powers of manipulation in the management of its material, cast steel, its design shows it to be the production of men devoid of any practical experience in the handling and use of artillery. Nor can we even bestow the praise that should belong to elegance in the choice of mechanical device and happy adaptation of parts, as a mere machine for a given purpose, either to the gun or its carriage. This gun is meant for a breech-loader. Its construction, as regards the movable parts of the breech, is much like that of the smaller natures of steel guns made at the Krupp works, but magnified. The result is that the movable parts of the breech plug are a good deal heavier than the ponderous projectile itself; and however pivotted or balanced, their mere inertia is such that the gun could be only with the utmost difficulty and slowness served, and by a large number of men. Of what use then is breech-loading here at all, if neither time, labour, nor exposure of a large number of men is saved by it? Why adopt at all a system which is inevitably attended with great weakening of the gun? But this is not all that is lost by breech-loading in this example. The external form of the gun seems to have been designed in total ignorance of the effects of abrupt changes of dimension upon the metal, where exposed to the strain and jar of explosion. The breech-piece is reduced suddenly by many inches in diameter below that of the outer envelope, which terminates towards the rear, just about the region of the powder charge. This comparatively small diameter of breech-piece is then mortised right through from one side to the other to receive the movable breech plug; the result is that so much metal is cut away as to leave the breech-piece itself dangerously weak against the longitudinal strain on explosion; and the suddenness with which this total reduction in transverse section occurs at the place we have named, must produce a jar, to speak popularly, at this point, which, together with the direct end on strain, will, we venture to predict, cause the blowing off of the breech, whenever this gun shall be fired a few rounds with adequate charges for even its service elongated projectiles. It is possible this fate may not soon await it, for it is rumoured that the gun itself has been presented by the Krupp Company to the Emperor of the French; and should peace continue with Prussia, it may probably not be deemed polite "to look the gift horse in the mouth," and the French artillerists will no doubt discern the ill-proportioning of the gun in time to save it from disgrace.

Not only is the gun itself thus unwisely designed and mal-proportioned, but we are unable to see any redeeming points in its mounting: the iron carriage, though heavy, is weak in several respects, and the apparatus for elevating and depressing is clumsily contrived. After a few discharges those long vertical screws which stand up parallel to each other at each side of the breech, would, we may almost surely predict, be found bent more or less, and so unmanageable, through their own inertia and the sudden jerk backwards of the recoil. The velocity of this jerk backwards when greatest has been greatly underrated even by scientific artillerists, and in reference to its effects we would draw the attention of artillerists to the memoir of Lieut.-Colonel Coquilhat of the Belgian artillery—*Sur les percussions initiales produites sur les affûts dans le tir des Boutes à feu*, published in the eighteenth volume of the Memoirs of the Royal Society of Liege.

Krupp exhibits a number of other steel guns and steel projectiles of various calibres, none possessing any specialities that have not been previously described. The Prussian government also displays steel guns, and the forms of breech-loading field guns, which were fully described in the *Practical Mechanic's Journal* some months ago.

The largest gun exhibited by France is the unfinished one in the shed of Petin, Gaudet, & Co. It is about 9 inches calibre (by eye only), but of great length, and is obviously intended to be used with a slow-burning powder. The forged central tube, which appears to have been made upon the coil system, is reinforced by an envelope shrunk on, which is cylindrical externally and reaches to the trunnions in one piece. The gun is bored from end to end, and either the breech-loading plan has not been decided upon, or is to be executed in the government arsenals, or remains yet to be done by the makers of the gun; but the public are given no hint of how it is to be carried out. The gun through form and proportion is by no means a strong one, but it may possibly, with a suitable powder, throw a projectile safely with a high velocity.

There are no other very large guns shown by any powers except by Great Britain. There are, however, many large and small guns of steel, wrought iron, and cast iron, shown by the northern powers; none, except those for field use, presenting much interest.

In heavy guns our English display is unrivalled. The war department shows the 12-inch wrought-iron muzzle-loading Woolwich rifled gun, with steel tube, mounted on wrought-iron casemate carriage and platform, fitted with compressors, &c.; also the 9-inch and 7-inch guns, fully mounted for naval service. Besides these there are the 7-inch wrought-iron breech-loading polygrooved rifle gun (the Armstrong proper), mounted for land service; the 64-pounder wrought-iron muzzle

loading shunt rifle; and the 64-pounder side breech-loading polygrooved rifle, mounted respectively for naval and for siege service; and the 40-pounder breech-loading polygrooved rifle for siege use. These as well as the field guns, 12-pounder and 9-pounder, are Armstrongs proper.

A magnificent forging for the breech-piece of a 25-ton gun is shown, bored, turned, and ready for shrinking on, constructed upon the Frazer system, weighing 15 tons, and the rough triple coil from which a similar forging would be made, weighing 20 tons. This coil consists of three annular thicknesses, each of a spiral twisting reverse to that next it. Besides the unquestionably great improvement that Mr. Frazer has effected at Woolwich in reducing the number of consecutive pieces shrunk on upon each other for built-up guns, resulting in a very great reduction in workmanship, and other material, fuel, &c., formerly wasted, he has devised and employed with success a form of reverberatory furnace, and a mode of welding under the steam hammer, that permits the welding together of these great rings in *triple* coils. There is scarcely a limit to the size to which these compound coiled rings, as thus brought to the welding heat in a vertical position in the furnace, may not be brought if necessary. The construction of a wrought-iron 36-inch mortar, which in 1855 was a new and difficult task, would now be an affair as simple and as certain as that of a 12-inch gun, indeed far more certain in the result as regards endurance; and whenever a great European conflagration shall occur, rendering the destruction of dockyards and arsenals, or the reduction of strong places indispensable, mortars of that magnitude will no doubt be called into existence.

At the entrance of the British gun shed two of the 36-inch shells, designed by Mr. Mallet in 1854–55, are exhibited. Their weight is marked at nearly 1¼ tons, and the range thrown at Plumstead 2640 yards, with 70 lbs. of powder.

There are no more interesting objects exhibited to the eye of the practical artillerist at the present moment than the models for the mounting of muzzle-swivelling cannon, shown by Austria and by Prussia. The history of muzzle-swivelling in Great Britain has been fully given in the pages of this journal. This method of mounting ordnance aims at enabling all the movements of the gun, both in training horizontally and in elevation or depression, to be made about an imaginary point at or near the muzzle of the gun, in place of training round such a point (as at present), and elevating or depressing round the centre of the trunnions. Were this carried out, a gun can be effective through an embrasure or porthole, which becomes limited to a circular aperture only a little bigger than the exterior of the gun at its muzzle. Of course all the extra area of the embrasure or porthole as now existing, through which projectiles or rifle bullets may come, is stopped up.

Mr. Mallet appears to have earliest set himself to the problem, and some years back he produced several different designs for thus mounting cannon to the Ordnance Select Committee. At a subsequent period Colonel Shaw, R.E., produced a very ingenious though complicated design for effecting the same object, which was tried by the authorities upon a 68-pounder gun with some success. Subsequently to that certain engineers in London patented a most extraordinary combination of complicated and ponderous parts for effecting the same end; and it is curious to find their wholly impracticable arrangement adopted by Admiral Halsted, and exhibited by him in Paris with his turreted ships. Prior to the date of this patent we believe a wholly different design of great simplicity was patented by Mr. Mallet, which has not yet been laid before the Ordnance Select Committee.

Such is in brief the history of muzzle-swivelling in Great Britain. The continental nations have been quite alive to the subject, and while in Prussia one method of effecting the object is shown, two are exhibited by the Austrian government. The Prussian plan is that of Herr Gruson, of Magdeburg, whose chilled projectiles are also shown. His arrangement is one of singular ingenuity and mechanical beauty, though we deem it liable to the fatal objections of complication, great costliness, and presenting a large amount of "top hamper" above and around the gun, any one part of which if deranged by even a single splinter, renders the gun for a time, if not for ever, unserviceable.

The gun itself, resting upon its trunnions, which are fitted into pillow blocks of cast iron, is placed between two large and high vertical cheek plates of cast iron, secured to the base of the carriage; these have segmental races of suitable size and depth to admit the trunnion block pillows placed in them at their interior and opposite sides. The gun, resting upon these pillow blocks, is also supported at two other points by radius bars, the remoter ends of which are pivotted in the cheek plates in such a manner that it is, when submitted to any force tending to elevate or depress it, subjected to constrained forces, the resultant of which gives the gun a motion in the vertical plane, the same as though it was pivotted to a horizontal axis across its own muzzle. The motion of elevation or depression is given by a pump at one side of one cheek, which sends water into a cylinder of an hydraulic press placed horizontally beneath the gun and between the cheek plates. Turning a cock passes back the water, and the gun descends by its own weight. The movements are perfect, and were the whole a machine designed for peaceful work nothing could be asked for further; but for the rough purposes of war we deem it completely inapplicable. The defence set up for this or any other complicated piece of ingenuity of this sort is, of course, that the very idea of muzzle-swivelling is to exclude all projectiles, that therefore any amount of complexity of apparatus may be admissible inside the turret or casemate. But though this be by hypothesis partly so, the entrance of solid projectiles or shells through the small circular apertures to which the embrasure is reduced is still possible at such times as the gun may be drawn back, and splinters may enter at any time. Hence any arrangements of parts that shall be full of complicated and interdependent parts, all liable to injury when struck, and injury to any one of which makes the gun unserviceable, are inadmissible.

The arrangements of Herr Gruson's slide platform are also extremely ingenious, and though also liable to the charge of complication, are less likely to become deranged than his apparatus for the vertical arc motions.

His slide is on the top surfaces curvilinear, so that the gun in revolving runs up a rapidly increasing slope. The carriage runs upon four rollers, all of which are eccentrically mounted as respects their axes (in this following the plan some years ago brought before the Ordnance Select Committee by Mr. Mallet, under the name of his Eccentric-concentric Roller, which, without any acknowledgment, has been since adopted entire in every form of the heavy naval and garrison gun carriages of Woolwich and of Elswick); and while the gun runs forward upon these rollers, it runs backwards upon its base as a friction slide. The rollers are turned so as to raise or lower the carriage by four cam motions of great beauty of arrangement, and these are perfectly automatic in their action, so that when the gun is fired the friction of the carriage is insured.

The Austrian government shows two different methods of mounting garrison guns so as to produce muzzle-swivelling approximately. Both of these depend upon constrained motions, due to giving the gun in fact four points of support, and in both cases the elevation and depression is produced by a screw. These designs, which are, like Herr Gruson's, exhibited by beautifully constructed models, though having much in common with the Prussian plan in principle, are incomparably superior to it practically, and make great advances towards simplification of parts. Still, no one of the three plans can be said to have solved the problem efficiently.

In the British gun shed our own Armstrong field guns are shown. The French, Italians, Belgians, Dutch, Prussians, and Austrians, and some others, show their respective field equipments more or less completely. Of several of these systems we have, within a year or so, given detailed descriptions in the *Practical Mechanic's Journal;* we need therefore only notice here that the French, Italian, and Belgian artillery present no wide points of departure from the common type settled by France, when she changed from the simplified smooth-bored guns of the emperor's design to rifled cannon. Nor do the Austrian guns materially differ from any of these. They exhibit their mountain artillery, which is extremely well devised, and would seem more effective than the French service, the mountain guns of which are reduced to a point of lightness that must suggest notions of unsafeness.

The most interesting exhibition of field artillery is that of the Dutch, who show the extremely ingenious and effective methods by which they were enabled to avoid condemning and recasting their whole stock of bronze smooth-bore guns, and yet to convert them into strong rifled bronze guns. This was done by heating each smooth-bore gun, and then running liquid bronze into and through the chase, until a complete union by surface fusion had taken place between the old bronze and the core of new thus run in. The latter was then bored out to the reduced diameter for rifling, so that the new gun when completed, not only was thicker than before, but was stronger for equal section than before, in

as much as its exterior parts had now a certain amount of initial strain or grip of the interior, like a built-up gun, or like the Rodman cast guns of the United States. It would be fortunate for us in England were this lesson of ingenious economy impressed upon us, so that it might in any degree lessen the reckless extravagance that characterizes the management of nearly every thing that belongs to our arsenals and dockyards.

Ammunition for artillery is exhibited by Great Britain with a completeness and unreserve not shown by any other nation, and by some this has been deemed an unsafe and impolitic course. We do not join in this view; secrecy in such matters is now-a-days, at least, out of the question, and we have quite as much to learn from foreign nations as they can learn from us. Some foreign time and concussion fuzes, for example, adopted into actual service, seem quite equal to ours in point of safety, exactness, &c., and greatly cheaper. The vice, indeed, of our British ammunition generally, is the useless perfection of workmanship bestowed upon a thing designed for destruction and to be destroyed. Work, finished with a beauty and perfection equal to that of an astronomical instrument, adds surely nothing to the perfection of a time fuze; if it does, the continental services manage to do without it.

One of the most singular pieces exhibited, is the American Gatling gun, which neither belongs to the class of field pieces nor of small arms. It is a sort of revolver, consisting of a chamber and six barrels, revolving round a centre pin. Metallic cartridges are kept ready loaded into any number of thin metallic tubes: one of these is fitted to the chamber, and a handle like that of a barrel organ is turned; the cartridges in succession are pushed into the barrels as they revolve and successively present themselves, and as each enters it is fixed; the whole thing goes on mechanically; all that is needed is to keep up the supply of cartridge stocked tubes, and to turn at a moderate and uniform rate. Each cartridge contains its own igniting powder, which is fired, as in the needle guns, by a point piercing it.

There are two sizes shown; the larger weighs on its wheels about 11 cwt., and the smaller about half that weight. These thoroughly American-looking contrivances are said to have been used satisfactorily in the Confederate war, and it is said also that a large number have been ordered by the American government since then. A gun very much on the general idea of this, but without mechanical arrangements or with revolving barrels, was exhibited and we believe fired at Wimbledon at the volunteers' meeting of last year. That bullet-showering machines of this sort, if they can be relied upon, would be highly useful in a few cases, cannot admit of doubt. The working of a gun through an ordinary embrasure or porthole might, for example, be rendered wholly impossible at a moderate range, were the cross fire of three or four such bullet "fire engines" directed upon it. So, again, the passage of a gateway, a street, or a bridge, might be made murderously difficult. But the notion expressed that such guns as this will ever become the efficient substitute for artillery, can only be entertained by those who have imperfectly understood the subject. No number of very light projectiles, though that were infinite, can play the part demanded by artillery, where mass and momentum are amongst the physical elements demanded, nor ever produce the moral effect on troops of great guns, especially in the field with *ricochet* fire.

It is singular to note the reproduction of this mechanical invention so many years after its first introduction. The revolving multi-barrelled gun was invented by the late Captain Day of the 11th regiment, who used seven barrels, six placed around a central one. The original weapon was in the possession of his family until 1858, at which time it was handed by his widow into other keeping. We believe the advantage of being able to discharge thickly-set showers of small shot occurred to that officer during his campaign in the Peninsula under the late Duke of Wellington, shortly after his introduction of improved percussion locks and caps, some of the former of which are still in use.

Small arms abound in all directions; our own Enfields, Whitworths, Sniders, and Lancasters. Needle guns in many sorts and classes. The Chassepot is no longer any secret; several of the regiments on guard about Paris are now armed with them. The sporting arms and *armes de luxe* exhibited by England and France, are in themselves a sufficient subject for a long article.

So also the material of armies, from powder barrels and parachute fuzes to field ovens, armourer's forges, stretchers and ambulances, with tools for manufacturing processes in cap, cartridge, and small arms, bayonet and cutting weapon making, &c.; for entrenching, for making army clothing, boots and shoes, wheel and spoke making, leather work, and a thousand other ends and uses, all attest the prodigious amount of thought and knowledge that have been brought to bear upon this one direful trade of human destruction during the last few years.

A day will yet come when men will look with amazement and scorn, such as that with which we regard the ignorant and barbarous violence of the mob of Crusaders of the middle ages, upon the fact scarce credible even to ourselves who live in the midst and know its reality, that Europe at this moment supports in arms, feeds and clothes not only in unproductive idleness, but in an occupation as mischievous and hurtful to mankind as is the poison of the rattlesnake, a mass of about 5,000,000 of men, a multitude equal to the population of all Ireland; that these men are sorcerized into the false morality that they fulfil their parts as *men* in the abnegation of every tie or human bond, but the one of being true to their service, to kill or be killed when ordered. Priest-craft cuts away every bond of sympathy between clericy and people, but soldierdom does worse; it not only isolates the man from his true and natural destiny, but it makes him a direct curse to his race, whether idle in peace or busy in warfare. In war, however good the cause, he is nothing better than the mere man of blood; in peace, the worse than drone in the human hive, trained to see the world around him through a false and dangerously distorted medium, practically forbidden to marry, and made the means of spreading moral poison wherever he is found. Nothing is easier than such platitudes, as that war seems the natural state of mankind, and that whether so or not, armies and war are at present necessary evils. Warfare is indeed the condition inevitable to barbarous and ignorant man, and while the human herd of nations remains so ignorant and so disunited as to tolerate despots, whether these be political, clerical, or military, wars must continue, and soldierdom, their pet implement, shall flourish. But let us always look the facts steadily in the face, nor ever let us mechanicians, who ought to be, and on the whole *are*, the harbingers of peace, forget either in the application of our own special powers to the apparatus of war, or in our admiration of the exquisite skill that others of our class have brought to its help, that war and all that belongs to it are hateful and abominable, and belong but to the kingdom of Chaos. We are all of us, and at all times, too prone to forget this, that never was needed more to be remembered than now, when, through the workings of two diverse despotisms in the east and west of Europe, the best and noblest portion of the whole human family seems likely within a few months to be deluged in blood. It was thus with a many-sided wisdom and a keen perception of the fact that in the main the soldier is but the tyrant's tool, that our forefathers forbade the existence of standing armies amongst us. That wisdom, the soldiering of other and at any moment possibly hostile nations has compelled us almost to abrogate. We may at any time, we are sure at some time, to have war forced upon us. We have thus no choice but to be prepared for the worst, and so though the task be hateful, in this as in everything to which we put our hands, let us quit us like men.

But to return: every human invention, however peaceful and beneficent in original conception, may be turned to warlike account, and like the spear of Achilles, given the double power to heal or wound. Thus the electric telegraph has been specially adapted to use in the field. In our own service this has not been neglected, and but very recently our apparatus, which is nearly identical with what is employed abroad, was rehearsed in a special field day at Chatham.

The Austrian and Prussian systems are both exhibited, and differ but in little. A spring covered wagon is fitted up to contain all the apparatus and to form a room for the military telegraph clerk wherever it may stop. Reel carts and barrows for distribution carry the conducting wires to be temporarily laid in any direction. The wires are either—if dry weather and other circumstances suit—common uncovered copper, passed over eyes in insulating stakes which are carried ready pointed and mounted for the purpose, or double insulated wires covered up in a single cylinder of gutta percha covered spirally with thin copper outside, and which can be simply laid loose along the ground. These wires were supplied during the late campaign to both the combatants, we believe, by Charles & Wehrner Siemens, of London and of Berlin. The telegraphing instruments employed, as well as the code, are reduced to as much simplicity as possible. We believe the French service adopt a code which admits readily of communication in cypher. Field telegraphs, though proposed and even constructed and tried some years ago, were really employed on an extensive scale first by the Americans

in the Confederate war. Their wires, we have understood, were nothing more than copper wire insulated with gutta percha, without any external metallic cover, and probably the reduction in weight and increased flexibility quite compensate for the slightly increased risk of rupture or cutting of the unprotected covered wire.

A system of signal, however, was employed by the United States, invented by a Mr. Caton, of Illinois, which seems more elegant and perfect than any other, for certain special uses at least. By this an officer in command of a position or post, quite out of view of his own commander, is placed in direct and momentary communication with him, and receives his signals audibly by means of a little electro-magnetic signal-box applied to his ear. The details of none of these systems are possible to be described without the aid of many illustrations.

Many occasions occur in war, both defensive and offensive, in which electro-telegraphy may be impracticable for the moment, or may be much less advantageous than some system which may instantaneously convey a piece of simple but definite intelligence, unmistakably, and to a great distance, and without any intermediate line of apparatus whatever. Such a system is found in that of flashing lights. The old beacon fire was, in fact, the rude precursor of these, and was perhaps older than historic time, and used by the men who dwelt in the "lake habitations" of Europe, and of whom no record is left but the bones of the animals, some of which are now extinct, which they toilsomely slew for food with the rude flint weapons that they fashioned. At a far later, but still at an extremely ancient period, the beacon fire was converted into a real signalling telegraph. In the Agamemnon of Æschylus, the poet has imagined the hero transmitting almost instantaneous intelligence of the taking of Troy to Clytemnestra by the lighting of torches held in the hands of a long line of men. This was light signalling, but Polybius, who was the military historian of Greece 150 years before our epoch, shows that the Greeks had a genuine system of light telegraphy. The twenty-four letters of the alphabet were divided into five groups; two stations, a right and a left hand one, were established at the post whence signals were to come; the exhibition of one, two, three, four, or five torches together, from the right hand station, indicated the group, and then the exhibition of the like torches together, to the number of one, two, three, four, or five, from the left hand, indicated the letter. For example: One torch at the right meant group one; three torches then shown at the left meant β, or four, γ, &c. There can be no doubt but that this system, rude and primitive as it was, could be worked pretty quickly, and, in fact, it is the basis of the system of naval signals by lanthorns in use to the present hour.

The Austrians exhibit a system of lanthorn signalling, but their most interesting display in this direction is of their system of flashing lights, which, illuminated by the electric arc, can be made available either for signalling or for peering into the distant darkness of the places supposed to be occupied by the enemy, and by a beam of local and artificial day compelling him to discover himself. The Drummond light was the precursor of this. The lime light, under the oxy-hydrogen jet, gave him the means of flashing signals across the whole northern end of Ireland, from the mountain tops of Mourne to those in Derry and Donegal; and by its means the great triangulation of the ordnance survey was made or checked. The intense luminous arc between the charcoal poles of a galvanic circuit, though not unknown in Drummond's day, was inapplicable; for Daniell had not given us yet the constant battery, nor had Ruhmkorff endowed us with his coil, by one or other modification of which, singly or together, or by machines derived from Faraday's discovery of magneto-electricity, we are now enabled, in most portable compass, to carry about with us, and in forms as little admitting almost of derangement as a grindstone, the means of evolving electricity capable of throwing upon a required point a light greater than that of a powerful flash of lightning. Both the Ruhmkorff coil and the frictional instrument, of which such excellent examples are produced by Herr Becker, the talented manager of the shops of Messrs. Elliott, at London, are employed by the Austrians. The luminous point is placed in the focus of a large parabolic reflector, and means exist not only for intermittent flashes, according to any required law, but obviously also for coloured lights, &c., if desirable. The great difficulty in the use of powerful lights such as these, to blind the enemy for the moment and discover what he is doing or his whereabouts, when the intervening distance is not great, nor outside the range of guns, as, for example, in siege operations, is that it is impossible so far to avoid throwing so much diffused light just around the focus as is sufficient to discover those standing by to the enemy, and the light itself becomes a mark for his fire also. It would seem quite possible to adapt to this special purpose some form of Mr. Thomas Stevenson's ingenious system of "apparent lights" that would remedy the evils so far at least as that the operators might be kept absolutely out of fire.

(*To be continued.*)

THE PARIS EXHIBITION.

TARS AND THEIR DERIVATIVES.

This article is the substance of a long and able paper by M. C. Knab, of Paris, which appears in M. Lacroix's "Etudes sur l'Exposition de 1867," a publication to which these pages have been already indebted.

Illuminating gas, as our readers are well aware, is principally produced by the distillation of coal. The gas in cooling leaves a deposit of tar, ammoniacal water (which is used in the manufacture of volatile alkali), several ammoniacal salts, and numerous bodies to which we need not further allude.

With regard to the gas, coke, tar, and ammoniacal water, they are obtained in various proportions, according to the quality of the coal. Close-burning coal produces but little tar, although yielding coke; small coal, which is purified with water for the manufacture of metallurgic coke, yields much less tar than the same coal in large masses. Again, with a low and relatively prolonged temperature, the produce of tar is always increased; with a temperature raised from the commencement of the distillation, the maximum of gas is produced and but little carbon; and the higher temperature not merely diminishes the quantity of the tar, but also affects its quality and value. In the case of gas works, where gas is the principal object, every effort is made to avoid the production of condensable bodies; but when the chief object is to extract tars and hydrocarburets, the process of distillation is carried on slowly and at a moderate temperature, at least at the commencement of the operation, because by these means the maximum of tar is obtained.

Some twenty years ago, when the manufacture of asphalt began to be extensively carried on, the idea occurred of extracting from tar a part of its oily constituents for the purpose of obtaining the solid pitch, in order to employ it in the manufacture of artificial asphalt, and for this purpose it is still largely used.

About eighteen years ago an inventor came to Paris with the proposal to form an artificial fuel out of tar and coal dust. This was made in cylindrical pieces in imitation of wood charcoal, with which it still competes. This manufacture consumes a large portion of the tarry products of the Paris Gas Company. At about the same period, the idea occurred at the same time to persons in England, Belgium, and France, of manufacturing an artificial fuel from a mixture of coal dust and from six to eight per cent. of pitch, mechanically combined by powerful pressure, and this manufacture has gone on increasing up to the present time. France does not produce enough pitch for the purpose, so that the manufacturers are obliged to have recourse to England for a further supply. After a while manufacturers, guided by chemists, distinguished amongst the oily constituents of tar two principal products, viz., benzole and phenic acid. The name benzole, or benzine, was originally given to all the more volatile products of tar, on account of its properties of dissolving fatty bodies; it is applied in domestic economy for taking out greasy stains, and it is also used for dissolving caoutchouc. Another of its applications is the imitation of certain natural flavours and perfumes; thus, pure benzole treated with concentrated nitric acid produces nitro-benzole, the odour of which much resembles that of the essence of almonds; and, under the name of essence of mirbane, it is also used to perfume soaps. Quite recently M. Witerhoeven, a Belgian physician, applied nitro-benzole with great success in the treatment of ulcers. Benzole has been employed to augment the illuminating power of gas when poor in carbon. Such a gas when passed through benzole takes up part of it, and thus acquires all the qualities of the most illuminating gas. Phenic acid is analogous to the creosote extracted from wood tars, and its preservative properties have also attracted attention. It is found in oils less volatile than benzole, and therefore called heavy oils, which are very complex in their composition. Such oils were first employed in England in the treatment of railway sleepers. From phenic acid was obtained picric acid, in

crystals of a brilliant yellow colour. This proved to be a powerful dye, for one part of it by weight was, when pure, sufficient to dye 1000 times its weight of silk.

These magnificent colouring matters, for which we are indebted to the persevering investigations of scientific men, are well represented at the Exhibition. Amongst these dyes France claims as her discovery —1. Picric acid, first applied to dyeing purposes at Lyons in 1847. 2. Fuchsine, a beautiful rosy-violet colour, the economical manufacture of which, so as to render it commercially available, was discovered by Verguin. Its price has been reduced from 200 to 250 francs per lb., which it fetched not more than five years since, to from fifteen to twenty francs per lb., its present price. 3. The beautiful fuchsine violets derived from it. 4. The dark blue and purple blues of MM. Girard et De Laire. From the dark blue was speedily made a light blue, which remains blue when exposed to gas or lamp light. 5. The beautiful emerald green, the finest of the colours extracted from tarry products, which was discovered in 1862 by M. Usèbe.

It must not be forgotten that the first production of a colouring matter by the oxidation of aniline is due to England. The fine violet colour, known as Perkins' purple, was discovered by that gentleman in 1856. The aniline black, discovered by Mr. J. Lightfoot, is also due to England; and Dr. Hoffman, whose scientific labours have been so useful in this manufacture, has been preparing for some time a violet of unequalled beauty, but which unhappily is not a very fast colour. Messrs. Poirier et Chapat, of Paris, have patented a mode of preparing an equally beautiful violet, the preparation of which appears to be more economical, and their exhibits are very fine.

Prussia, Germany, Belgium, and especially Switzerland, also exhibit some remarkable specimens of all these manufactures. Every year increases the number of colours made from tarry products: phenic acid, besides the picric yellow, serves for the preparation of rosolic acid and some very beautiful rosy tints; there is not one, not even excepting naphthaline itself, the most abundant and cumbrous product, but that seems destined to enter the lists. Pure phenic acid, in addition to its well known antiseptic properties, which nearly equal those of creosote, begins to perform an important therapeutic part. Some years since tar was found to be very effectual in the cure of certain sores, and it has been discovered that this result is due to the presence of phenic acid. Attention has been turned to this product, and it is now obtained exceedingly white and in a crystallized and very pure state, and some fine samples of it may be seen in the Exhibition. For some time past phenic acid has been greatly in favour in England, as an example of which we may mention that the Lords of the Admiralty have decided that it shall be used throughout the Royal Marine for the purpose of disinfecting the holds of ships. Since the late cattle plague it has been much used in England for purifying stables, slaughter-houses, &c.

M. Dony, a professor at Ghent, has discovered a method of burning the heaviest tar oils without smoke, and with a vivid light, in a lamp of special construction, named after him, which was introduced into France about six years ago. These heavy oils, when decoloured, also begin to be used for painting and for the manufacture of common varnishes.

As before stated, coal tar is obtained from two sources—gas works and the manufacture of metallurgical coke, both of which yield a tar containing very nearly the same products; but as there are peculiarities in each mode of production, we shall speak of them separately.

Tar is separated from gas by a process of cooling. The ammoniacal water is condensed at the same time, and the whole is run into cisterns, where the tar, being heavier, separates itself from the water. The tar is first distilled in proximity to the gas works, in large retorts of sheet iron, capable of containing as much as 20,000 litres (4400 gals.), and the larger the apparatus is made the better can the more volatile products be separated from the heavy oils. These boilers, not having to withstand any pressure, are made of various forms. From experience, we strongly recommend the cylindrical form as the simplest and strongest. The boiler, or large horizontal boiler tube, is provided at the part opposite to the furnace with a very large cock for the purpose of running off the pitch, which is always liquid when warm; the cock is placed quite at the bottom, and the boiler slightly inclined at that side, so as to insure its being entirely emptied. The boiler is provided with a manhole to facilitate cleaning, and which serves at the same time for the filling of the boiler; and with a wide pipe, capped at the top for the evacuation of the distilled products, the cap on this pipe being furnished with a small tube for the introduction of a thermometer, the bulb of which is immersed in the vapours. The boiling point rising from 95° Fahr., for the more volatile products, to upwards of 572° Fahr. at the end of the distillation, it is necessary to heat with a furnace.

Attempts have been made to distil tar like alcohol, continuously, by causing the tar to be continually introduced, and the residuum also continually run off; but considering the very small proportion (from 3 to 6 per cent.) of highly volatile products, these processes, even should they work regularly, do not appear to be of much importance. Whatever be the process of distillation employed, the operation should be prolonged according to the nature of the tars and of the residuum that it is desired to obtain, until the tar has lost as much as from 25 to 40 per cent. of its weight. The distiller must be guided by the quality of pitch he wishes to produce, and experience alone can teach him the necessary indications in this respect. Three kinds of pitch may be produced—1. Resin, liquid, or at least pasty, at a low temperature, the residuum of the tar, of which it is desired to extract the more volatile products, those containing the benzoles. This pitch serves for the manufacture of Paris charcoal more economically than tar, since the most valuable products have been previously extracted. 2. Pitch, solid at the ordinary temperature, hard and brittle when subjected to cold, but which becomes so soft at high temperatures as to admit of being considerably extended. This pitch is especially designed for the manufacture of artificial asphalts. 3. Common pitch, very hard and brittle, the form of which is scarcely affected at all by the highest summer temperature. It is employed extensively in the manufacture of artificial fuel, and some establishments use more than 10,000 tons of it annually.

When the distillation of the tar has proceeded sufficiently far, the fire is let down, and the pitch is allowed to run off into a proper receptacle. With regard to the volatile products of the distillation, these are condensed by ordinary means, being conducted by the neck of the retort into a worm kept cool by a current of water; but for tars containing much naphthaline, and when the operation is carried so far as to leave only common hard pitch on the retort, the complete cooling of the worm should not be continued to the end of the operation: the oils must be allowed to come away warm, for otherwise the naphthaline, which speedily crystallizes when subjected to cold, would stop up the worm. During this distillation, first very volatile, then less and less volatile products are evolved, the boiling temperature of the products continually rising until the end of the operation. This ascending scale of the boiling points of the products has attracted the attention of many experimenters, who have sought to make them separate themselves as they severally come over.

The following is the usual mode of operation:—All the volatile products of the distillation are divided into three parts, and each part is run into a separate receiver. The first fractional part comprises—1st, the water that tars always contain, charged with ammoniacal salts; and 2nd, the whole of the more volatile products, of which the principal are amyline, benzole, toluol, xylol, cumol, and picoline, of which the boiling points will be given hereafter. As soon as the thermometer indicates a temperature of 302° Fahr., the second fractional separation begins. The products above mentioned are always accompanied by phenic acid and other carburets, notwithstanding their higher boiling point. The proportion of the products of this first separation (excluding the water) to the tar is very variable. We have known it vary from 3 or 4 per cent. of the weight of the tar to 6 or 7 or even 8 per cent. These products mark on the Baumé areometer about 25° or 26°.

The second fractional separation comprises, in addition to a small quantity of all the above products, a considerable proportion of phenic acid, the boiling point of which is 370° Fahr.; some acid products, as saponifiable as phenic acid; and naphthaline, which, notwithstanding its high boiling point, is found in all the products. This separation is stopped at 392° Fahr. of the thermometer, and the products mark 15° Baumé.

The third fractional separation (which contains also a large quantity of phenic acid and saponifiable oils, some quinoline, very appreciable quantities sometimes of aniline, an enormous proportion of naphthaline, in fact all oils of a high boiling point) yields what are called heavy or creosoting oils; these mark only 5° on Baumé's areometer, water marking 10°.

In the tar works of the Paris Gas Company these heavy oils are preserved in immense sheet-iron tanks, until they are barrelled for despatch to different creosoting works.

The treatment above described is only applicable to those which are tolerably rich in volatile products; but in the case of poor tars two separations are sufficient, viz., all the products up to 392° Fahr., and then the heavy oils. The volatile products evolved by the distillation of tar, though composed of only four simple bodies, viz., carbon, hydrogen, oxygen, and azote, combined, two or three at a time, in various proportions, are rather numerous; for about twenty-five of these combinations are well known, and there are several more which have received but little attention. They will be found classified in the following table:—

TABLE SHOWING THE VOLATILE PRODUCTS FROM THE DISTILLATION OF GAS TARS.

	Composition.	Density of Liquid.	Boiling Point.
			Deg. Fahr.
1st. Acid Bodies (CHO).			
Phenic acid,	$C^{12} H^5 O + HO$	1·065	370
Rosolic acid (in very small proportion), Xylic acid	—	—	—
2nd. Basic Bodies (CH Az).			
Aniline,	$C^{12} H^7 Az$	1·028	360
Quinoline,	$C^{18} H^7 Az$	1·081	448
Pyridine,	$C^{10} H^5 Az$	—	302
Lutidine,	$C^{14} H^9 Az$	—	310
Lepidine,	$C^{20} H^9 Az$	—	500
Collidine,	$C^{16} H^{11} Az$	0·921	356
Petinine,	$C^8 H^{11} Az$	—	176
Pyrrhol,	—	—	267
Picoline,	$C^{12} H^7 Az$	0·955	—
Cryptidine,	—	—	—
Parvoline,	—	—	—
3rd. Neutral Bodies or Hydrocarburets (CH).			
Benzole,	$C^{12} H^6$	0·850	177 to 186
Toluol,	$C^{14} H^8$	0·870	109 to 118
Cumol,	$C^{18} H^{12}$	—	303
Xylol,	—	—	262
Cymol,	$C^{20} H^{14}$	0·861	347
Naphthaline,	$C^{20} H^8$	1·048	423
Paranaphthaline,	$C^{30} H^{12}$	—	572
Anthracine,	$C^{28} H^{10}$	—	upwards of 572
Chrysine,	$C^{12} H^4$	—	572
Pyrine,	$C^{30} H^{12}$	—	572
Eupion,	C H	—	338
Propyline,	$C^6 H^6$	—	Volatile.
Butyline,	$C^8 H^8$	—	—
Amyline,	$C^{10} H^{10}$	—	102

It will be seen from this table that the products which come over at or below 302° Fahr. are amyline, benzole, petinine, toluol, xylol, picoline, and pyridine; those that come over between 302° and 392° Fahr. are cumol, lutidine, eupion, cymol, collidine, aniline, and phenic (carbolic) acid; whilst those that require a temperature above 392° Fahr. are naphthaline, quinoline, lepidine, paranaphthaline, anthracine, chrysine, pyrine, &c.

This mode of classifying the products of distillation is not, however, strictly correct in practice. Naphthaline, for instance, is frequently present in the second, and sometimes even in the first fractional separation. Phenic acid, too, the boiling point of which is near the limit of the second separation, will also be found in some considerable proportion in the third, as the heavy oils contain a sufficient quantity of it to render them efficient in preserving timber from decay.

Besides the method of separating the various bodies by fractional distillation, there is another method by means of mineral acids, and a third by the use of caustic soda.

In treating the products first separated, after having removed the water, we proceed to a first rectification in cylindrical iron vessels, containing from 2000 to 4000 lbs. of the products, and heated by steam. The distillation should be made very regularly, without starts, until two-thirds of the contents of the retort have been vaporized. What remains in the retort is united to the products of the second separation, after, however, having thrown down the naphthaline, which almost always settles when subjected to cold. The condensed vapours contain principally amyline, petinine, benzole, toluol, xylol, and a small quantity of all the other less volatile products, and probably some hydrocarburets still unknown.

The amyline, or alcohol of tar, may be next separated by putting aside the first product of the distillation, and adding it afterwards to the benzoles. The proportion of this product, however, is small. The remainder of the products are collected in a tank, where the water separates on standing. The products are then submitted to methodical washing processes, intended to remove the ammonia and its combinations, then the bases and acids.

The following are the processes of treatment:—1st, Washing with pure water, to carry off the ammonia and its combinations. 2nd, Cold washing with 3 or 4 per cent. of sulphuric acid, which dissolves the basic products, and carries away a little naphthaline and some impurities. The mixing should be effected vigorously, and, if possible, by mechanical means. After two hours' standing, the acid tar becomes completely settled, and is run off at the bottom. The products which float on the surface are transferred to a third vessel, where (3rd and 4th) they are again washed with pure water; and on being transferred to another vessel, they are (5th) treated with a solution of caustic soda, to carry off the last traces of sulphuric acid and the organic acids. Vigorous stirring, followed by twelve hours settlement, and removal of the soda combined with the acid, precedes (6th) another washing with pure water. After six hours settlement in the same vessel, another washing (7th) with pure water takes place. After standing six hours, the supernatant oil is removed, its chemical treatment being now finished. The vessels used for this treatment are usually of cast iron, and cylindrical in form. In order to effect a thorough washing, not more than 600 or 800 lbs. of the products should be treated at once.

The products under treatment are immediately transferred to iron tanks. They contain now only neutral hydrocarburets of a low boiling point, that is, benzole, toluol, xylol, a little cumol, and some other neutral products; and they are left to settle until they become limpid, when they are withdrawn and submitted to a second rectification in retorts containing from 600 to 800 lbs. The heat should be applied either by means of high-pressure steam or a bath of palm oil, in which the retort is immersed. In order to obtain the products free from colour, the head of the retort should be of copper tinned in the interior, and the refrigerating worm should be of tin. The process of rectification should be carried on regularly, and under the guidance of a thermometer. The benzole and toluol are usually collected together, in which case the operator has to separate all that passes over until the thermometer reads 230° Fahr.; and this product constitutes the benzole destined for the manufacture of aniline, and the essence of mirbane. The products next condensed are very white and limpid; there are still traces of benzole and toluol, but more particularly of xylol, cumol, and probably some hydrocarburets, as yet unknown, of a corresponding boiling point. These products, collected between 230° and 260° Fahr., are put aside, and serve for the cleaning of textile fabrics, the solution of caoutchouc, and other purposes. The products which pass over above 260° Fahr. have many of the properties of the last preceding. The residuum in the retort is extracted when cold, and is added to the products of the second fractional distillation.

Benzole and toluol have each their special qualities for the manufacture of aniline, for which reason some manufacturers keep what comes over up to 194° Fahr. separate from the product of distillation above that degree and 230° Fahr. The first part contains 70 per cent. of benzole and 30 per cent. of toluol, whilst the second contains 70 per cent. of toluol and 30 per cent. of benzole. If perfectly pure benzole be required, the products which pass up to 186° Fahr. should be submitted to the action of cold; the benzole crystallizes, and by compressing it the toluol is squeezed out. But in practice this state of extreme purity is rarely called for.

As to the treatment of the second fractional distillation of the products between 302° and 392° Fahr., we have already stated that the residuum of the rectification of the products of the first separation, and that of the second rectification of the benzoles, are added to the products of the second separation, and this mixture also undergoes a first rectification in boilers containing from 2000 to 4000 lbs. The products are separated in the following manner: up to 248° Fahr. the condensed products are added to the product of the first separation of the distillation of the tar; from 120° to 190° the products are collected and put on one side, and the residuum contained in the boiler is returned

to the tar. The collected products undergo washing with water and treatment with sulphuric acid and caustic soda. The purified product contains only neutral bodies, or hydrocarburets of a high boiling point.

The second rectification is made in a palm oil bath; the temperature of steam at high pressure would not be sufficient to complete the operation; the retort is provided with its thermometer. At the commencement of the distillation a little benzole and toluol is always collected, which is added to the similar products previously obtained; next a small quantity of some colourless and very limpid product is collected up to 262° Fahr., and added to benzole No. 1; between 262° Fahr. and about 375° Fahr. comes benzole No. 2, and sometimes with products which pass over above 302° Fahr. a third quality is made, less fine and limpid than the above, the residuum of the distillation being mixed with the heavy oils, and containing a considerable quantity of naphthaline and other carburets of high temperature.

As the various operations we have described are rather complicated, we shall give a summary of them in a tabular form :—A, Products of the first fractional part of the distillation of coal tar; B, Products of the second fractional part; C, Heavy Oils; 4, Residual Pitch.

A.—First Rectification.

Two-thirds of the products to be rectified.
Residuum added to products of second separation.

Second Rectification.

Chemical treatment of the two-thirds :—
Amyline, &c.
Benzole and toluol.
Benzole, No. 1, to take out stains.
Benzole, No. 2, do.
Residuum added to products of second separation.

B.—First Rectification.

Products up to 248° added to products of first separation.
From 248° to 374° collected separately.
Residuum returned to the tar.

Second Rectification.

Chemical treatment of the essences from 248° to 374° :—
Benzole and toluol mixed, added to products of first separation.
Benzole for taking out stains, No. 1, up to 262°.
Do. do. No. 2, up to 284°.
Do. do. No. 3, up to 302°.
The residuum returned to the heavy tar oils.

It must be kept in mind that the operations we have sketched out are to some extent a theoretic outline, perfectly applicable to gas-coal tars rich in products, but which must be more or less modified for poor tars.

The specimens of this class of products exhibited are very numerous. Among those firms who exhibit we may mention the following :—In the French section, the Paris Gas Company, M. Felix Dehaynin, T. Coupier, J. Casthellaz, Carvès & Co. (St. Etienne), Coblenz Brothers, H. Védlès, and the Lyons Fuchsine Company; in the German section, Broner (Frankfort), J. Rutgen (Berlin), T. Wurtz (Leipzig), and Weiler & Co. (Cologne); and in the English section, Demuth (Birmingham), Calvert (Manchester), and C. Lowe & Co. (Manchester). Some of these manufacturers have exhibited, in addition to mixed benzole and toluol, and the products applicable to cleansing purposes, some fine specimens of hydrocarburets, neutral and pure, of which the annexed is a list of the principal, showing the respective boiling points indicated by manufacturers and chemists :—

	Boiling Points, Fahr.	
	Chemists.	Manufacturers.
Pure crystallizable benzole, . . .	186°	176°
Toluol, ...	109 to 118	217 to 219
Xylol, ...	262	259 to 261
Cumol, ...	303 to 151	298 to 300
Cymol, ...	347	339 to 341

We have already described the manner in which the crystallizable benzole may be isolated from the toluol, and the other three essences are also treated by successive rectifications, and separated from the cleansing benzoles in which they are found, the nearly regular differences between them in the boiling point allowing this to be done. Let us add that cumol, like benzole, crystallizes under cold, and this affords a second means of separation for the last two products.

Messrs. T. Coupier and Coblenz Brothers exhibit in the French section some fine samples of crystallizable benzole, toluol, xylol, cumol, and cymol, and M. J. Casthellaz of crystallizable benzole, toluol, and cumol. In the English section there are some fine specimens exhibited by Messrs. Demuth & Co. of the five neutral essences, which are the only ones that have as yet been produced in a state of purity.

Let us not, however, forget the most abundant of the tarry products, viz., naphthaline. This product, which may be obtained in the enormous proportion of 20 or even 50 per cent. of their weight, has not been used to any great extent, but is beginning to be applied to the production of colours. It has also been employed to preserve growing trees from the attacks of insects; and it constitutes perhaps the greater part of the creosoting oils used for the preservation of wood. Almost all the above-named exhibitors have sent some fine samples of crystallized naphthaline, in beautiful white and nacreous plates, rhomboidal in form, which dissolve at 174° and distil at from 414° to 446° Fahr. The crude naphthaline, deposited from the heavy oils and from the products of the second fractional distillation, may be purified with facility by first pressing it, in order to extract as much as possible of the accompanying oils, and then sublimating as in the case of sulphur: the napthaline vapours condense in the receiver as brilliant spangles. If it is required to obtain it perfectly pure, it should be dissolved in boiling alcohol, from which it will separate itself again in crystals by cooling. We give these details believing that naphthaline is destined to take a more important position than it at present occupies. It differs from other valuable products of the same class only by containing a larger proportion of carbon, its composition being $C^{20}\,H^{8}$, whilst the most carburetted neutral benzole is represented by $C^{12}\,H^{6}$.

Turning now to the acid bodies obtained on the distillation of tar, several have acquired considerable importance, especially phenic, or carbolic acid, and rosolic acid, each composed of three simple bodies, viz., carbon, hydrogen, and oxygen.

Phenic acid, having its boiling point at about 370° Fahr., exists in a large proportion in the products that come over between 302° Fahr. and 392° Fahr. The acids combine with the caustic soda employed in treating the products of distillation. The resulting phenate is dissolved very thick in five or six times its volume of warm water, and after being well agitated it is left to cool. The naphthaline settles, and some oils emulsioned by the soda float over the surface of the solution of the phenate. The clear part of the solution is withdrawn into another vessel, and is saturated with a slight excess of muriatic or sulphuric acid diluted with water; by leaving it to settle the denser salt of soda sinks to the bottom of the tank, and the phenic acid and some other organic acids which accompany it float on the surface. The phenic acid is then run off into a third vessel and is well washed with water. After being transferred to a fourth vessel, where on standing the water separates from the acid, it is submitted to distillation. All that comes over up to 365° Fahr. is kept separate, and what passes over between that degree and 373° Fahr. is crude phenic acid, which in winter crystallizes in the condenser, but in summer it must be induced to crystallize by artificial means. The crystallized produce is sufficiently pure for most manufacturing purposes, but in order to obtain it in a state of greater purity, the crystals must be submitted to pressure in order to separate from them the accompanying oil, and it may be necessary to submit it to a second rectification, in which case only what passes over at the boiling point of the acid must be retained. The crystallized product, after being again submitted to pressure, is nearly pure phenic acid.

The before-named exhibitors show fine specimens of crystallized phenic acid. Messrs. Lowe & Co.'s samples are good, but we especially refer to Mr. Calvert of Manchester, not only on account of the excellence of his exhibits, showing such variety of form, but because he was one of the first to direct his attention, and that with much energy, to this product for its disinfectant, antiseptic, and therapeutic qualities. The Paris Gas Company also exhibit specimens of phenic acid and liquid phenate of lime for disinfection. Crude phenate of lime is produced with facility, like phenate of soda, by treating the oils, the boiling point of which is between 302° Fahr. and 392° Fahr., with cream of lime, which combines with the phenic acid. The solution when decanted and allowed to settle thoroughly, is fit for disinfecting purposes, the phenic acid being slowly evolved, like the chlorine of chloride of lime, and being replaced by the carbonic acid of the air. M. Bobœuf has exhibited numerous samples of phenate of soda in solution for disinfecting and therapeutic purposes. Phenic acid is accompanied in tar oils by very small quantities of other organic acids, probably formed during the processes employed, the most important of which is rosolic acid (well shown by Mr. Calvert and Messrs. Lowe & Co. in the Exhibition), but this acid is not extracted direct from the tar, but is obtained from phenic acid.

The Paris Company, at the instance of M. Regnault, have been making experiments with a view to prevent the excessive formation of naphthaline, by separating a part of the carbon it contains. The action of concentrated sulphuric acid on the heavy oils liberated from phenic acid also reduces the proportion of carbon. Samples of decolorized heavy oils so prepared are exhibited by the Paris Company and M. Felix Dehaynin. A striking instance of the effect of high temperature is afforded by the manufacture of gas from pine and fir wood, as practised in some towns of Germany and Switzerland. When wood is distilled like coal in a retort, the gas evolved has not much illuminating power, but on the other hand considerable quantities of tarry oils are deposited after the gas has left the retort. If, however, all the products of the distillation are conducted into refractory tubes heated to a high temperature, the tarry oils are decomposed, the gas becomes highly illuminating, and the tars are completely changed in their character.

Benzole and the other essences do not originally exist in the coal, but are evidently formed by multiple reactions at a high temperature between the oxygen, azote, hydrogen, and carbon. The water contained in pit coal converted into steam at a high temperature, is probably not without its influence on these reactions. It is not improbable then, that by a profound study of these phenomena, and by causing steam to intervene, we should succeed in influencing the combinations in such a way as to produce an increased amount of illuminating gas, or of valuable oils.

CHARCOAL AS A PURIFIER OF WATER.

CHARCOAL has long been recognized as a valuable filter for purifying water containing organic or inorganic substances. A paper was recently read before the Institute of Civil Engineers, embodying the results of a number of carefully conducted experiments, made for the purpose of exactly determining how much reliance might be placed regarding the effect of this substance in purifying water.

The results of four sets of experiments were given, the first on animal charcoal, of which nearly five pounds new and freshly burned, and of the degree of fineness used in sugar refineries, were packed in an ordinary stoneware filter. The water employed (of which a complete analysis was given) contained, in the gallon, organic matter, 10·80 grains; inorganic matter, 88·30 grains. The hardness of the water, before boiling, was found to be 50°·50, and after boiling, 33°; and the oxygen required to oxidize the organic matter contained in one gallon amounted to 0·0116th part of a grain. Several gallons of the water were allowed to percolate slowly through this charcoal, and upon examination afterwards, it was found that, of the inorganic matter which had originally existed, 52·60 grains were removed from the first gallon; but from each succeeding gallon less and less; so that from the twelfth gallon of water that passed through the charcoal only 8·80 grains of inorganic matter were removed. Of the organic matter 4·80 grains were removed from the first gallon; but, with a gradual decrease, the charcoal ceased to remove any organic matter after the sixth gallon. In fact, immediately afterward, it commenced to give back a portion of the organic matter removed in the first instance, the quantity returned to the twelfth gallon amounting to 1·55 grains. Thus, of the 13·54 grains of organic matter removed by the charcoal from the first six gallons of water, as much as 4·98 grains were given back to the next six gallons; from which the author concluded that, had this set of experiments been carried a little further, all the organic matter removed at first by the charcoal would have been given back again. The second and third series of experiments were with wood and peat charcoal, which, however, were still less satisfactory than those with animal charcoal. The fourth set of experiments was on animal charcoal, with water previously treated with permanganate of potash slightly in excess. After remarking that the water, in its passage through the charcoal, was found to contain organic matter, apparently in the same quantity as before treating it with the permanganate, attention was drawn to a comparison between the first and fourth sets of experiments, to show how closely they agreed to contradict the general statements made as to the removing power of charcoal, and to demonstrate how very little indeed could be done by this filtering material, even on a small scale, toward the purification of water.

The author, in conclusion, gave it as his opinion, that as by chemical agency bad water could be purified to a very limited extent only, the public mind should more than ever be given to the great question of supply; and as people valued their lives, they should above all things, in their choice of a source, not be too much influenced by distance, but be willing to undergo the necessary expense of securing the object of their search, not only in abundance, but in the greatest purity.

Our readers will not fail to notice that, in connection with these experiments, what appears to be as equally an important discovery is, that the *organic* matter only is given back, whilst the *inorganic* matter, after being separated, was not given back. It may be perhaps that, had the experiments been carried further, which we hope they will in due time, that the inorganic matter is not returned until after the organic matter is quite separated from the charcoal; but that after separation is effected, it may be given back.—V. D.

ON SOME POINTS OF PRACTICE IN IRON FOUNDING.

No. XIX.

Pit Casting—Gun Founding—American Methods.

ONE of the most important applications of pit casting is unhappily that of cast-iron gun founding, and it has always been so since the middle of the fifteenth century, about which period, in England and in the then more advanced countries of Europe generally, cast iron came to be somewhat largely substituted for bronze, as that had supplanted the still earlier wrought-iron staves and rings, or tubes and rings, as materials for ordnance. While, on the Continent, gun founding in cast iron has always been under the more or less direct control of government establishments, just as the casting guns in bronze was also—in England, though the casting of bronze guns was always viewed as the exclusive function of the government arsenal, yet, oddly enough, cast-iron gun founding was intrusted to contracts placed in the hands of one or two large foundries, such as those of Carron, the Walkers, and Low Moor. Although cast-iron guns have long been cast, and often of excellent quality, at private establishments in Bristol, Newcastle, Glasgow, Liverpool, and elsewhere in England, yet casting iron guns for our government remained, until a very recent period, practically a monopoly with the two or three great British foundries we have named. When the demands of the Crimean war showed the inadequacy of our gun-producing powers to meet a sudden emergency and great demand, a great establishment was formed at Woolwich for casting iron guns. Experience was wanting, however, on all hands, and was not possible to be improvised in the newly-created establishment; and the first essays in iron gun founding there were scarcely encouraging, though under the immediate control of one of the most able and devoted officers in our service, Colonel Wilmot, R.A.

Almost at the same moment the Armstrong gun movement commenced, and, backed by General Peel—at the time, and for a brief period then, minister at war, with whom it is, we believe, neither untrue nor unfair to say it was mainly a move of policy and party—soon assumed such proportions as to extinguish in official circles in England the expectation that cast-iron guns were ever again destined to play any considerable part in armaments, and finally to cause the unwise destruction of the grand and costly plant that had been established for the cast-iron gun foundry at Woolwich, and the conversion of the foundry into workshops for Armstrong guns.

The Americans, not only through the necessities of the case, due to the slight development of their manufactures of wrought iron and the deficiency of heavy tools prior to the Confederate war, had from the earliest period of their national independence adopted cast iron for material of guns. Although never quite neglecting wrought iron as a gun material, and occasionally obtaining from Europe specimens, such as the first unfortunate "Princeton" gun of wrought iron, and having inventors, or plagiarists passing for such, amongst them such as Professor Treadwell, proposing various forms of wrought-iron cannon; still wrought iron was unpopular as well as dear, and had been more than once, though on very insufficient grounds, reported against formally by government authorities.

Meanwhile researches and experimental inquiries as to the best conditions for cast-iron gun founding were never wholly suspended, and have resulted in the collection of a body of facts as to that material, and the mode of applying it to gun casting, superior to that produced hitherto by any other nation. It is right to observe, however, that *all* which the Americans have produced in print as part of these researches

is not to be accepted without examination, and even caution. Not only are some of the experimental methods adopted, as described by Major Rodman, U.S.A., and others, objectionable, but some of the deductions laid down as guiding rules, seem to rest upon a very insufficient logical basis, even granting, for what they may be worth, the facts upon which they rest. About June, 1855, investigations of a precise nature were for the first time published in Great Britain, which cleared up the nature of the internal stresses to which artillery is subjected when fired, and pointed out practically, and for the first time with exactitude, as deductions, the principles of construction of guns in superposed rings with initial tension.

We do not digress here as to who was, or was not, the originator in Great Britain of this great advance, already become so largely and importantly applied all over the world; but we must not omit to affirm the fact, that the discovery of the laws and the invention of the method of ringed structure with initial tension was certainly *not* American, and that the claim so audaciously set up for himself by Treadwell is devoid of any true foundation.

The *principle* of initial tension, however, once thoroughly known and mastered by the Americans, they very soon began to consider how far it might be possible to apply it to their cast-iron guns, and thence originated the system of iron-gun casting upon cores, and of cooling more rapidly from the centre—*i.e.*, by the intervention of the hollow core—than from the exterior, as in all anterior methods of casting. This method, commonly known as the Rodman method of gun casting, has undoubtedly constituted a decisive improvement and advance, and has enabled the Americans to cast guns of a magnitude and with an endurance—their great calibre considered—far exceeding anything previously deemed possible in dealing with cast iron.

The visit of the *Miantonomah* last year with two of these huge guns of 15-inch calibre, dimensions which have since been exceeded, in like guns of 20 inches calibre, at length awakened European governments to the importance attachable to these methods of gun founding; and at last, within a few days of the time at which we write, one of those 15-inch guns, having been purchased by our government, has been tried at Shoeburyness, and with very remarkable results. Into these results we do not propose to enter here, though much more is required to be said about them than we have as yet seen printed in English, before their real merits and demerits shall have been fully put forward. Our object here is merely to affirm the importance to the iron founder of the method itself, by which these vast pieces of ordnance are cast, as the fitting introduction to the very full account which we purpose here to give to our readers, as successive portions of those papers on "Some Points of Practice in Iron Founding," of the researches which have preceded the American method of gun founding, and of the method itself.

For the greater portion of the account which we shall present we are indebted to a most able and comprehensive Russian memoir, by Colonel Axel Gadolin, read by him not long since to a conference of artillery officers at St. Petersburg, and published in the Russian *Journal of Artillery*. Were we, as in strictness perhaps we ought in papers dedicated to iron founding as a scientific art, to confine ourselves merely to the peculiar methods of pit casting by which these American core-cast guns are produced, we should give an account which, though sufficient perhaps for the founder, would yet be very incomplete for the scientific artillerist. Our iron-founding readers must therefore bear with us for beginning this branch of our subject at the beginning, and referring very fully to the researches upon the metal itself employed made in America, &c. The facts, so far as they are well based, and where they appear to us to be otherwise we may have occasion for remark, will be found of far wider application, and of more general importance to the founder, than in their restricted application to gun founding.

A few words may suffice, before proceeding to this, to sketch the older methods of gun casting in iron. There is no certain evidence derivable from the examination of the oldest cast-iron pieces which exist, that any were ever cast otherwise than vertically and in pits. On the other hand, as the bell founders of the East and of Europe were the oldest founders upon a large scale of any sort; and as they cast bells moulded in loam vertically from an early period, there is every probability that their vertical method would be at once transferred to the kindred art of gun casting in bronze, and from thence to gun casting vertically in iron. The moulds for the earliest guns were formed by moulding the form of the gun in loam, and in some later instances in plaster of Paris where fine ornament in relief was intended, and then forming round that a loam "cope," which was cleared of its core model by one or other of two different methods. Either the loam gun model was formed upon a wood spindle, with hay bands wrapped round it, and then the spindle was withdrawn after the cope had been completed, in several separate short lengths meeting end to end. Then the core model was picked out bit by bit from the interior of each piece of cope in succession, and when all were cleared, the pieces were put together and fitted, and the gun cast. Or if the model were in plaster, the cope pieces were made in halves—*i.e.*, with a longitudinal junction; when these were removed in succession, and finished, they were built together again in the pit, as this was rammed up round them, and poured.

These methods of gun casting were almost universal up to the days of St. Remy and of Belidor, and to the early part of the eighteenth century. The next marked improvement in gun moulding seems to have been produced at Carron—namely, the substitution of a cast-iron case or jacket, made in segments longitudinally and transversely, and jointed by flanges and bolts and nuts, for the bare stiff "cope" of loam. Within this jacket the loam, or sometimes the "dry sand," was moulded from a wood model, either withdrawn by being made in pieces, or by taking the cope asunder longitudinally. Much time and expense were thus saved, by the model being permanent, and by the necessity for ramming the mould up in a pit no longer existing.

The iron jacketted loam moulds were simply stood upright in a dry pit, and poured. The general habit everywhere was to pour the metal right into the open top of the mould, which was provided with a high *masselot*, or rising head. The air carried down with the descending stream of molten metal was let to escape as best it could. Gaits passing down in the substance of the loam so as to enter the mould at the bottom were not unknown, and are said to have been employed in casting the larger natures of carronades (64-pounders) at Carron, but their use was infrequent.

The iron was melted in earlier days always in the air furnace, but in more recent ones frequently in the cupola; and we can only express it as our own opinion, whatever that may be worth, that as good guns may be cast by one mode of fusion as by the other, provided the founder have skill and knowledge enough to choose properly the mixture of his iron, and regulate his furnace or cupola in reference to that.

However, in the following statements, we shall find much on the subject of the proper quality of metal, and the effects on it of the modes of melting. We proceed, then, to the latest improvements in gun casting—viz., those of the Americans, as described by Colonel Gadolin.

From the time when means became known of casting objects in iron of sufficient hardness and tenacity, the low price of this material caused it to be generally employed for the manufacture of cannon. But it soon became apparent that it was not very safe. The accidents caused by the bursting of cast-iron guns then caused artillerists to determine to prove the new pieces, and only to accept those whose powers of resistance appeared established. These proofs, which were successively improved during a great many years, conformably to the results of experience and the progress of science, have doubtless much diminished the number of bad guns delivered for service, but yet they could not give complete security, and accidents continue to the present time in spite of every effort made to prevent them.

The only certain method of proving a gun consists in firing a great number of shotted rounds with ordinary charges, but this method renders the gun unfit for further service, and consequently can only be considered as a guiding proof to which a few guns may be submitted, chosen out of a greater or less number. The greater requirements of artillerists, and the increasing strictness used in the acceptance of samples of iron, have, as a consequence, compelled the founders to improve their processes of manufacture. A great number of very varied trials has resulted, but as the metallurgy of iron has only received a scientific direction within thirty years, it is evident that chance has played a large part in the results. The consequence of this was that where a satisfactory result had been obtained in a foundry, the experiments were at once abandoned to pursue, even to its minutest details, the process which had once signally succeeded. The art of casting good iron guns has thus become the appanage of a few privileged foundries, and they, favoured by chance and their reputation once

established, have remained stationary; so that when the improved methods of making powder, the increase in calibre of the pieces, and the introduction of rifled ordnance have successively demanded increased resistance in the guns, these foundries were found unable to meet the new requirements. Accordingly we constantly see, on the one hand, a great number of guns of small powers of resistance, and on the other, some whose resistance is astonishing. It is hence incontestible, then, that cast iron is a material of which remarkably strong guns may be made; and this admitted, the whole question is limited to finding the causes of non-success—causes which can exist only through imperfections in the manufacture of the guns. Certainly the founders have at all times taken much pains to find the causes of failure; but the meagre results they have obtained, and especially the fact often observed that two guns poured even from the same melting, and under apparently identical conditions, show very different resisting powers, should convince us that several circumstances of the manufacture, hitherto unnoticed, play a very important part. It is evident, then, that to arrive at any satisfactory result, a detailed and complete analysis of all the circumstances which can influence the strength of guns is indispensable. Such inquiries can only close when very complete, but for the same reason they demand the co-operation of many individuals experimenting in different places and under different circumstances, but with a common system. This implies considerable expenditure of money and time, which naturally is shunned by the owners of large concerns. As to the experiments made by different governments, with a view to create cannon foundries, it has generally happened that when these establishments were not successful in at once producing good guns, it was preferred to return to private foundries in the enjoyment of an established reputation, rather than plunge into a long series of researches, the success of which remained uncertain.*

In America, a new country, a country without traditions, it has been determined in this case, as in many others, to begin at the beginning. The citizens of the United States do not like to depend on the Old World.† Even in matters of science they do not accept the facts or figures given by the *savants* of Europe, until the experiments have been repeated by themselves. So that from the time when they heard of the first cannon burst in Europe in 1841, they regarded all guns of European manufacture with suspicion, and immediately set to work to find means of making better in their own country. The chief Comptroller attached to the foundries, or, as they say in America, the superior inspecting officer of foundries, received an order in consequence to examine as completely as possible the properties of cast iron and bronze, to study the samples of iron and the pieces themselves in each stage of manufacture, to lay down rules for their proof, and to point out the necessary appliances and machines. Several foundries had already, by contract, furnished cannon. Those of West-Point, Pittsburg, George's Town, and Richmond had notably made a great number of cast-iron guns which were in service. When the question of the insufficient strength of cast-iron guns was raised, and it was averred that in the manufacture of these guns every necessary measure had not been taken which could guarantee their resistance, it became indispensable to determine the degree of strength of the guns already cast in the country. For this purpose an officer was charged with drawing up a system of proofs to which to subject specimens of iron taken from all existing cannon, and which specimens had to be taken in such a way as not to diminish the subsequent strength of the pieces in service. This officer was also charged to classify the guns in three categories, according to the degree of strength they showed in the experiments, and the guns of second and third quality, that is to say, the doubtful and bad ones, were to be provisionally withdrawn from service. The collection of all these researches has taught American artillerists some important scientific results as practical suggestions for new modes of founding iron guns. We shall describe them succinctly; and, first, as to the proof of the guns in service.

To obtain the specimens of metal from the guns in service, a hole was bored in the muzzle of each piece of annular section, so as to leave a small cylinder of cast iron in the middle, which was afterwards removed when the hole had attained the required depth.*

Specimens were thus taken from 2808 guns cast in America from 1827 to 1840, and all these specimens were examined with the threefold regard, to the texture and appearance of the fracture, the density, and the mechanical strength. The results obtained were very variable. For instance, the density varied from 6·9 to 7·4, and it was remarked that the strength generally varied with the density. Yet this was not without exceptions; sometimes a great density corresponds to a moderate resistance, and at others it is the reverse; but in the latter case the resistance is never *very* great. These anomalies were commonly indicated by the appearance of the fracture. In the former case the fracture was tolerably white, or slightly speckled on a silvery white ground, or else uniformly dull, somewhat resembling the fracture of earthy matter. In the second case, when a low density corresponded to a pretty great strength, the fracture had a more sombre appearance; it was more like graphite, and was composed of a compact mass of small crystals.

The guns were classed in the following manner:—The first class consists of guns, the metal of which shows a resistance of at least 24,500 lbs. per square inch, and a sufficient density (7·18 to 7·25, and even 7·16 to 7·30), and the fracture presenting generally the appearance of good iron. The cannon of this class were regarded as fit for service. In the third class were the guns, the specimens from which had a density less than 7·01, and a tensile resistance of 20,000 lbs., or less, per square inch. These pieces were considered unfit for service. Again, the second class comprises doubtful guns, such as all those whose specimens showed a bad proportion betweeen the densities and resistances.

The general result of the classification of the 2808 guns cast before 1841 is shown in the following table:—

TABLE I.

No. of Guns in each Class.	Mean Density.	Mean Tensile Resistance Per Square Inch.
1239 First class, ...	7·200 ...	26,430
932 Second class, ...	7·143 ...	23,467
637 Third class, ...	7·100 ...	21,018

To verify the method adopted, eight pieces of each class were taken to submit to a firing proof; namely, six guns, 24-pounder, cast at Westpoint, two of each class; six guns, 24-pounder, cast at Richmond, two of each class; six guns, 32-pounder, cast at Westpoint, two of each class; six guns, 32-pounder, cast at Richmond, two of each class.

The firing was arranged as follows:—500 rounds were first fired with one shot, and the ordinary charge of one-fourth the weight of the shot. If the piece resisted this, the number of balls was gradually increased until the chase was entirely filled. When this limit had been reached, the charge was increased to half the weight of the shot, and the maximum number of balls which the gun could contain.

With two cannons of the third class, the number of rounds with the ordinary charge and one ball was 800. The charges were increased as follows:—The 24-pounders fired fifteen rounds with 6 lbs. of powder, and two, three, four, up to sixteen balls; and one round, with 12 lbs. of powder and sixteen balls. The 32-pounders fired fourteen rounds with 8 lbs. of powder, and two, three, four, up to fifteen balls; and one round, with 16 lbs. of powder and fifteen balls.

After the completion of this programme, the 24-pounder, No. 186, fired besides, eleven rounds with 12 lbs. of powder and sixteen balls, and burst; and the 24-pounder, No. 7, fired five rounds with the same charge, and the same number of balls, without bursting.

The results of this proof are given in Table II., as well as the densities and strengths of the different specimens taken from the guns. This table shows:—1st, That the first series of shots (one ball and the charge of one-fourth) has caused to burst—one gun of the first class, three guns of the second class, five guns of the third class. The gun of the first class burst at the 371st round; but its vent was a little widened before the proof, which admits of the belief that it had already stood 200 or 250 rounds. 2nd, That after the completion of the programme, there remained not burst, five guns of the first class, two guns of the second class, one gun of the third class.

These results are decisive; for if they do not prove to a certainty

* There are at present in Europe twelve foundries of iron guns, belonging to seven governments—*i.e.*, in France, Ruelle, Indret, and St. Gervais; in Austria, Vienna and Mariazell; in Prussia, Spandau; in Russia, Petrozavodski and Verchnié Tourinsk; in Spain, Trubia; in Italy, Turin and Naples; in Belgium, Liège.

† This independence is of the highest import in all that concerns war munitions. Foreseeing the possibility of a war lasting for several years, Congress votes annually a large sum for the purchase of saltpetre, and this primary material is preserved in great quantities in the arsenals.

* We shall see by the tables further on that it was not always considered enough to take the specimens from the muzzle, but that they were also sometimes taken at the trunnions and breech. We shall also see that some of these specimens were parallel and others perpendicular to the axis of the piece, and that there was a considerable difference in the strength of these two kinds of specimens.

that all the guns of the first class were capable of firing a great number of rounds, they at least prove that the method of judging of the strength of guns by the mechanical proof of the metal is good, and that the American government has been thereby enabled to remove a great number of bad guns, and consequently to considerably improve the average quality of those in service.

Table II. gives rise to several observations. First, if the 24-pounder, No. 1, which showed itself very weak, was yet put in the first class, it was because regard was not had for all the circumstances which should influence the classification. In fact, we see by this table that the strengths of the different specimens taken from gun No. 1 differed considerably; thus, while the resistance of the specimen taken at the muzzle (by which the gun was classed) was 28,208 lbs. per square inch, it was only 22,744 and 22,009 for the two specimens taken at the breech; so that if the first specimen had been taken at the breech, the gun would have been put in the second class.

Another circumstance which has escaped the American artillerists is that, among the second class guns, there are three whose mean density (of the six specimens) is less than 7·1. These are Nos. 163, 287, and 290; and with No. 294 they are precisely the weakest of the second

TABLE II.

Number in Order.	Calibre and Number of the Guns.	Class.	Specimens Taken Perpendicular to the Axis of the Bore.						Specimens Taken Parallel to the Axis of the Bore.						Proof.			
			At the Muzzle.		At the Trunnions.		At the Breech.		At the Muzzle.		At the Trunnions.		At the Breech.		Number of Rounds Fired.			Guns which have Withstood the Proof.
			Resistance.	Density.	Resistance.	Density.	Resistance.	Density.	Resistance.	Density.	Resistance.	Density.	Resistance.	Density.	Ordinary Charge.	Increased Charges. Ch. ½.	Ch. ¼.	
1	24-pounder, No. 1,	1	22,855	7·173	23,560	7·165	22,774	7·173	28,208	7·180	21,444	7·099	22,009	7·160	371	"	"	"
2	" " 40,	1	26,382	7·170	23,984	7·163	23,278	7·151	29,055	7·209	19,751	7·133	27,793	7·169	500	14	"	"
3	" " 193,	1	26,947	7·151	24,689	7·150	22,714	7·146	28,208	7·185	26,946	7·152	27,088	7·160	500	15	1	"
4	" " 186,	1	24,689	7·144	26,805	7·162	26,100	7·156	28,067	7·185	20,739	7·148	26,382	7·158	500	15	12	1
5	32 " " 10,	1	"	"	"	"	"	"	31,734	7·245	"	"	"	"	500	14	1	1
6	" " 11,	1	"	"	"	"	"	"	31,744	7·210	"	"	"	"	500	14	1	1
7	" " 137,	1	"	"	"	"	"	"	29,337	7·190	"	"	"	"	500	14	1	1
8	" " 136,	1	"	"	"	"	"	"	28,780	7·170	"	"	"	"	500	14	1	1
9	24 " " 7,	2	25,253	7·161	24,266	7·160	23,419	7·150	22,566	7·150	25,112	7·171	20,598	7·115	539	15	6	1
10	" " 163,	2	21,162	7·110	19,046	7·067	18,481	7·061	23,272	7·150	19,892	7·089	21,021	7·095	409	"	"	"
11	" " 287,	2	24,407	7·078	21,162	7·063	23,702	7·076	23,836	7·147	24,125	7·073	24,548	7·079	277	"	"	"
12	" " 290,	2	22,714	7·072	22,291	7·070	23,560	7·086	23,413	7·123	22,573	7·079	19,046	7·063	500	6	"	"
13	32 " " 294,	2	16,930	7·142	20,480	7·183	20,480	7·190	22,284	7·196	26,805	7·196	18,764	7·159	318	"	"	"
14	" " 63,	2	"	"	"	"	"	"	23,131	7·145	"	"	"	"	500	14	1	1
15	" " 59,	2	15,519	7·201	16,647	7·250	15,519	7·218	22,425	7·264	19,610	7·277	23,278	7·284	500	12	"	"
16	" " 20,	2	21,162	7·199	16,789	7·185	20,739	7·197	22,570	7·232	21,444	7·222	26,241	7·240	500	13	"	"
17	24 " " 173,	3	20,598	7·141	14,108	7·132	21,021	7·138	19,040	7·140	14,108	7·126	23,278	7·162	800	15	1	"
18	" " 174,	3	14,390	7·131	15,519	7·156	16,930	7·160	14,104	7·100	14,108	7·120	21,441	7·160	500	13	"	"
19	" " 309,	3	19,469	7·049	20,880	7·067	20,880	7·064	20,028 21,453	7·080 6·996	21,162	7·078	20,457	7·052	148	"	"	"
20	" " 301,	3	18,053	7·054	19,892	7·053	20,174	7·057	20,874 19,897	7·085 6·967	17,635	7·031	19,892	7·056	208	"	"	"
21	32 " " 324,	3	16,083	7·002	18,340	7·037	19,046	7·036	19,323 18,815	7·090 6·960	19,469	7·039	20,316	7·043	52	"	"	"
22	" " 325,	3	16,365	7·003	17,635	7·015	19,092	7·024	19,464 20,132	7·024 6·922	18,199	7·003	17,635	7·013	112	"	"	"
23	" " 450,	3	15,378	7·083	14,108	7·095	14,108	7·092	17,348 13,405	7·108 7·140	15,660	7·110	16,506	7·110	89	"	"	"
24	" " 424,	3	"	"	"	"	"	"	16,930	7·164	20,739	7·076	22,009	7·256	800	14	1	1

class. These cannon were put in the second class, because the specimens taken at the muzzle showed a density above 7·1, and a resistance of between 23,000 and 24,000 lbs. per square inch; but if the classification of the guns had been according to the mean density, they would have been put in the third class.

On the other hand, Nos. 173 and 424 of the third class would have been put in the second if the guns had been classed by the specimens taken from the breech in place of those from the muzzle; so that, if this plan had been adopted, the guns which burst would have been divided as follows:—

	Burst by Ordinary Charges.		Increased Charges.	Total Guns Burst.
1st Class, 7 guns,	0	...	2	2
2nd " 8 "	2	...	3	5
3rd " 9 "	7	...	2	9

The two following facts are deducible from the mode of classification adopted by the United States:—

1. When the mechanical test was made of the specimens taken from the guns of Fortress Monroe, it was remarked that nine guns cast at Richmond, and belonging to Series 354 to 370, should all have been put in the third class. From information received on the subject of the eight other guns of this series, it was ascertained that they had burst during the ordinary proof at reception.

2. Among the thirty-two guns coming from the West Point Foundry, those of the Series 308 to 337 having given but indifferent results in the mechanical proof, the journal of the foundry was consulted, and it was found that these guns had been cast in 1839 from hot-blast iron. They were, in fact, the only guns from that foundry cast from this kind of iron, and they were all classed as weak guns six years after their reception. While No. 308, the first of this series, only showed a resistance of 20,732 lbs. per square inch, and a density of 7·09, the preceding, No. 307, cast from cold-blast iron, showed a resistance of 25,246 lbs., and a density of 7·185.

As it was interesting to ascertain if any relation existed between the tensile resistance and the chemical composition of the iron, there were submitted to analysis

13 specimens taken from guns of the 1st class.
5 " " " 2nd "
14 " " " 3rd "

The following table gives the mean composition for each of these categories:—

TABLE III.

MEAN COMPOSITION IN 100 PARTS.

Class	Graphite.	Combined Carbon.	Si.	Scoriæ *	Sul.	Phos.	Mn.	Mg.	Ca.	Al.	K. and Na.
1st,	2·06	1·78	0·85	0·16	0·018	0·53	2·33	0·039	0·051	0·128	0·019
2nd,	2·30	1·46	1·06	0·13	0·015	0·81	1·51	0·012	0·043	0·159	0·028
3rd,	2·84	0·76	1·08	0·26	0·024	0·70	2·47	0·058	0·045	0·198	0·034

* That is to say, involved slag, silicate of iron and of earthy bases.

These figures show that in proportion as the strength of the iron diminishes, the quantity of graphite increases and that of combined carbon diminishes; but that the quantities of silicium, sulphur, phosphorus, manganese, magnesium, and calcium, as well as the amount of scoriæ, vary in an irregular manner. As to the aluminium and alkalies, their

increase is regular, but their quantity is so small that they cannot be supposed to have any influence. Other than this, no relation can be found in the detailed tables of the analyses between the quantities of these substances and the strength of the iron.

So much cannot be said for the carbon, and especially for the graphite. In the guns of the first class the maximum of graphite was 2·5 per cent., while in the third-class guns that which contained the least had still 2·45 per cent. This is easily explicable; the particles or plates of graphite, which in themselves offer scarcely any resistance, being interposed between the molecules of the iron, necessarily diminish the cohesion of these, whence the strength of the iron decreases in proportion to the increase in the quantity of graphite. The influence of the combined carbon is less easy to grasp. The maximum of combined carbon in the first-class guns was 0·95 per cent., and in fourteen specimens taken from guns of the third class, ten contained still less, and one specimen is stated to have contained none at all.

The quantity of sulphur is too small to have exercised any influence on the strength of the iron, but the silicon and phosphorus vary within limits which make it at least probable that they exercise some influence. Their mean quantity increases from the first to the third class. Nevertheless, such great anomalies are met with in the details of the analyses that we must conclude that other causes have had a greater influence. The manganese has no injurious effect.*

The conclusion to be drawn on the whole from these experiments is this: a tolerably exact idea of the goodness of cast-iron guns may be got from the density of the metal, and its resistance to mechanical testing. This resistance increases with the diminution of the graphite and the increase of the combined carbon. We shall see further on how far these results have been confirmed by later experiments.

(To be continued.)

MR. HENRY'S RIFLES.

As is well known, Mr. Henry, of Edinburgh, is one of the very few competitors whose weapons have been selected for trial by the recent order from the War Office, and although we are not at present about to describe the arms that he is to send in, for very obvious reasons, still we think that the latest productions at his hands will be interestedly looked for.

Fig. 1.

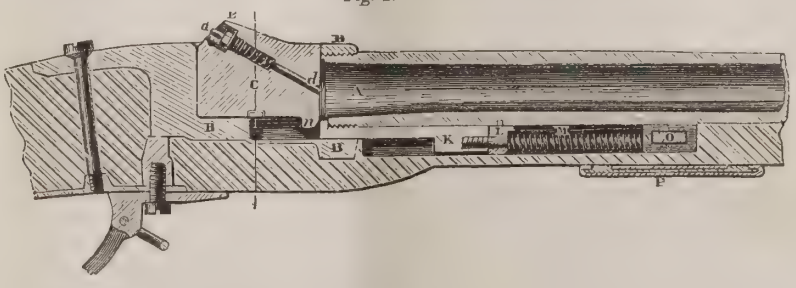


Fig. 1 of the woodcuts is a longitudinal section of an improved breech-loading rifle. Fig. 2 is a side elevation corresponding to fig. 1; and figs. 3 and 4, details after referred to. In fig. 1, on account of the section being taken along the axis of the barrel, A, the details of the lock are not shown, but it may be here stated that locks of the ordinary construction are used. The barrel, A, is screwed into the hollow body or break-off piece, B, which is also formed to constitute the cavity for the reception of the breech-closing piece or breech proper, C. The breech, C, is formed with a hinge joint, D, seen in transverse section at fig. 3; this fits between two similarly formed lugs or projections, and the pin or bolt, F, passes through them, thus hinging the movable breech to the arm itself. Thus it is obvious that the breech-piece, C, will, by either being lifted out of, or shut down into the cavity, open or close the breech end of the barrel, A. When the breech-piece, C, is shut down, it is held or retained in that position by means of that end of the spring, *a*, marked *c*, which, as shown at fig. 2, is formed so that the semicircular end may catch into a correspondingly formed recess, *c'*, in the cavity; this recess, *c'*, being cut in a piece of steel fitted therein, as shown at fig. 2. The tension of this spring is sufficient to retain or hold down the breech, but it is not sufficient to hinder or prevent the lifting it up when required to reload the arm. The spring, *a*, is also formed with a second end or tail, *b*, which, as shown at fig. 3, constantly presses against the other side of the breech cavity, so that as soon as the opposite end, *c*, is released from the recess, *c'*, the pressure of this part throws the breech-piece up out of the breech cavity, which is then left open for withdrawing the spent cartridge case and for reloading. The piston, *d*, by which the ignition of the cartridge is struck, passes through the breech-piece, C, as shown at fig. 1, and the upper side of the breech-piece, C, is formed into a hood, E', which protects the exposed end of the piston, whilst the hammer, D, is so formed that its end falls directly upon the piston within the hood. The act of drawing back the hammer, D, at the same time releases and causes the breech, C, to be thrown open. The hammer, D, is provided at the lower end with a projecting spur or toe, *f*, shown at fig. 2; in lifting the hammer then the end of this spur or toe, *f*, is also elevated through an equal angle, so that during its elevation the toe being in contact with the projecting end of the slide bar, *g*, fig. 2, shown also in the obverse at fig. 4, the slide bar is correspondingly elevated, so that its upper end being in contact with the lip of the breech-piece, C, the breech-piece is similarly lifted and releases the spring, *c*, from the recess, *c'*, and the tension of the other end of the spring, *a*, instantly causes the breech-piece, C, to be thrown completely up, leaving the breech cavity empty. On being carried through the complete angular movement, the toe, *f*, passes below and comes out of contact with the slide bar, *g*, so that on shutting down the breech-piece the lip of the breech again forces the bar, *g*, to its lowest position, in readiness for being lifted to release or open the breech. In lowering the hammer or in firing the arm, the toe is enabled to pass below the lower end of the slide bar, *g*, by the following arrangement:—The bridle or guide-plate, *h*, sustaining the bar, *g*, has an angularly formed recess made in it, as shown in the obverse view, fig. 4, and the bar, *g*, is maintained in the position shown at fig. 2, by the pressure of a small spring, *i*, which bears against it, and by means of the slide bar, *g*; being thus sustained, it is capable of yielding to the pressure of the toe, *f*, as this is lowered; as soon then as the toe, *f*, has passed below the lower end of the bar, *g*, the spring, *c*, forces the bar, *g*, back into its position, in readiness for again being acted upon for the purpose of lifting the breech-piece. The extractor consists of the bar, K, which passes through and is constructed so that

Fig. 2.

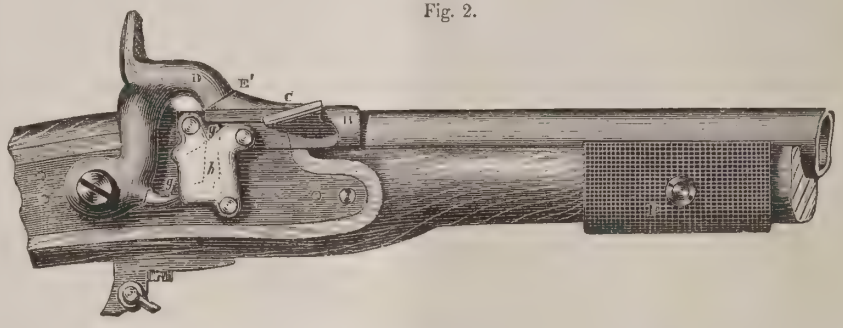


Fig. 3.

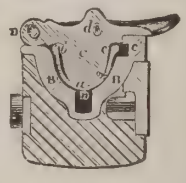


Fig. 4.

* The authors of these analyses, Messrs. Murphy and Boot, in their first report show a certain accordance between the chemical composition and the strength of the iron; but in their later report, sent in when all their analyses were finished, and when confidence might be felt in more reliable figures, they no longer find any relation between the chemical composition and the strength.

These gentlemen attribute the want of accordance, to inaccuracy in the experiments on the resistance, and maintain that it is not worth while to establish a comparison, and consequently they abstained from deducing the mean results of each class. Consequently, when we take the means and compare them with those of the first report, we find no difference; the means on which the conclusions of the first report were based are still the means. It is difficult to understand then what has caused these gentlemen to change their minds. If conclusions based on figures could be influenced by personal considerations, perhaps the anomaly might be explained by the death of Captain Walbach, superior director of the experiments, which occurred in the interval between the first and second reports.

it may slide in the lug, L, fixed to the lower or under side of the barrel. A coiled spring, M, surrounds part of the bar, K, as shown, and being compressed between the lug, L, and the head, N, of the bar, K, it maintains the extracting end of the bar flush with the end of the barrel. The extracting end is slightly turned upwards, as shown, the projecting piece fitting into a recess in the end of the barrel, and is also formed to catch the flanch which surrounds the base of the cartridge. A cross bar, O, passes through the head, N, of the bar, K, and also passes through the sliding hand-piece or guard, P, thus holding these two parts together, so that when it is necessary to extract or withdraw a cartridge the hand is applied to the hand-piece or guard, P, drawing

Fig. 5.

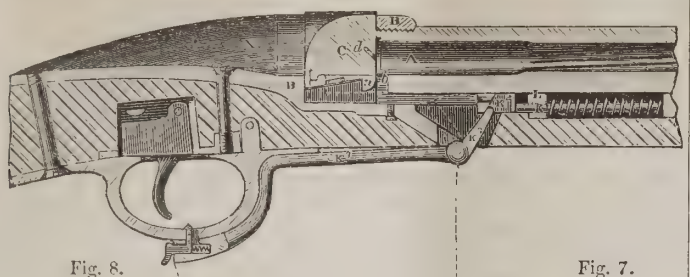
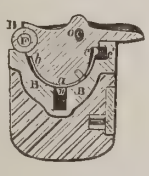


Fig. 8.

Fig. 7.



it towards the breech, which action forces out the extracting bar, and therefore the spent cartridge case, by means of the upturned end of the bar catching into the flanch of the case. The guard or hand-piece, P, is formed, by preference, of a light iron or steel or other metallic framework, which may be covered with leather, as shown at figs. 1 and 2.

In a second arrangement, the chief difference from the preceding consists in the form or shape of some of the parts, and in the manner of actuating the extractor. Fig. 5 is a longitudinal section, fig. 6 a side elevation, fig. 7 a transverse section of the breech-piece, C, figs. 5 and 6, and fig. 8, is the obverse view of the slide bar, *g*,

Fig. 6.

and the guide-plate or bridle in which it slides, and by which it is held to the lock-plate by the three screws, as shown at fig. 7. The extractor bar is made in two portions, K and K^1, joined together by an open link or eye piece, K^2; the spiral spring being placed over the round part, K^1, maintains the end of the bar flush with the barrel; but when it is necessary to extract a spent cartridge case the lever, K^3, is pushed into the position shown by dotted lines at fig. 5, and in being so moved, the short end acting upon the bar, K K^1, carries the extractor forward to a proportionate extent, and the upturned end of it marked, *a*, catching in the flanch at the base of the cartridge case causes the latter to be withdrawn, and on releasing the hand from the lever, K^3, the tension of the spring acting upon the head of the bar, K^1, draws the extractor as well as the lever, K^3, back into their former position, after which the arm is ready for reloading. In connection with this modification, Mr. Henry employs the hollow recess marked X, in fig. 5, the advantage of which is that as soon as withdrawn from the barrel the spent cartridge case at once falls away.

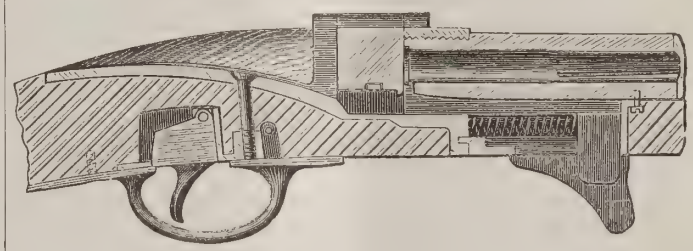
In connection with the second, the preceding, and succeeding modification, two bevelled projections, *n*, shown at figs. 1 and 5, formed on the under edge of the front face of the breech-piece, C, are used, their object being to force the cartridge completely into the chamber as the breech-piece is being shut down or closed, and also for forcing the extractor back into its seat, in the event of any obstruction causing it to project.

In all these arrangements, the nipple through which the piston passes is inserted considerably below the upper edge of the recess or hood, E′, thus leaving a part of the recess or hood, E′, free for the striking part of the hammer to enter (which it cannot do until the breech is perfectly closed), thereby affording an additional and secure bolting of the breech before the instant of ignition. Or in place of forming a complete hood or recess, E′, as shown, a projection at the back and below the nipple will answer the same purpose. In place of forming the retaining and upthrowing springs in one piece, they may be made of two separate and distinct pieces, which may be fixed to the breech-piece, C, by one and the same screw, or otherwise, as required.

In place of fixing the lifting bar, *g*, to the exterior of the lock plate, it may be fixed to the interior of the same plate, in which case it would be acted upon by the tumbler of the lock; or the bar, *g*, may be so formed that a part of it should project through a slot formed in the lock plate, which would be acted upon by the toe or spur, *f*.

In place of forming the lever for actuating the extractor, as shown at figs. 5 and 6, the trigger guard is sometimes formed in one piece with the lever, thus dispensing with the ordinary trigger guard. A

Fig. 9.



catch is formed at the back end of the trigger guard, by which it may be held up into position as an ordinary trigger guard, the catch holding in a nut or piece of metal attached to the stock to retain it.

At fig. 9 is shown another mode; this, however, principally consisting in the form of, and means by which, the extractor is actuated. The form of the extractor bar, K, will be best gathered from an inspection of the longitudinal section. At the rear end of the bar, K, the piece, 1, is fixed, to which is secured the piece of wood, ebonite, gutta percha, or other material, marked 2; so that on applying the hand to the piece, 2, the extractor is sent forward. A frame, 3, is placed for the metallic projection, 1, to slide in; it is held in place by the screw, 4, and its front end is held by entering a recess, 5, formed in the iron nut by which the lock is attached to the stock. In other respects this modification is similar to the second.

From what we have said a clear idea of what Mr. Henry is doing may be gathered. After having made a careful examination of these arms, we are satisfied of the fitness of their arrangements. Others seem to think so too. We recently saw an Italian rifle which had been altered for that government by Mr. Henry to the first arrangement we have described.—V. D.

JOTTINGS IN THE FRENCH EXHIBITION.

PLATINUM.

Of the rarer metals, platinum is the most useful. It is the heaviest of all metals, being more than twenty-one times heavier than water. Of the acids, only a compound of muriatic and nitric acids will act upon it, and it requires a very high temperature, such as that produced by the oxy-hydrogen blowpipe, to melt it. By hammering it may be extended into thin sheets, and it may be drawn into wire, which possesses very great tenacity. Wire only the 1940th part of an inch in diameter has been made of it. This metal, from these properties, is of great use to

chemists; and gold refiners, who require sulphuric acid in a highly concentrated form, make use of retorts composed of platinum. It has been usual to solder together the pieces composing these retorts by means of gold, but as that metal is attacked by strong and hot sulphuric acid, the vessels sooner or later gave way at the joints. Messrs. Johnson, Matthey, & Co., have, however, discovered a method of making a solder of platinum itself, and in their case at the Exhibition they show some platinum retorts which have been put together by what they term autogenous soldering. For this invention, which renders such vessels more durable, and therefore less expensive, they have deservedly obtained a gold medal. One of the retorts is large enough to concentrate 8 tons of sulphuric acid a day, and its value is £2490. Another retort is smaller, but by its means 5 tons of acid may be concentrated daily, and its value is £1640. These vessels are made of chemically pure platinum. They also exhibit a platinum still; also siphons and tubes of several diameters, for use in a mint or in a gold and silver refinery; a thick circular disc or ingot of chemically pure platinum, value £1100, forged all at once in a mass, sufficient for the construction of a retort such as the smaller one already mentioned; three ingots of pure platinum, value £520, produced by melting the metal by the heat of the flame of oxygen and hydrogen combined. They also exhibit some models, amongst which is that of an ingot of platinum the largest ever made, weighing 220 lbs., and having a value of £3400. The original ingot was made by St. Claire Deville's process of heat derived from the flame of the combined gases, and it appeared in our Exhibition of 1862. Messrs. Johnson & Matthey show various other specimens of their platinum ware, such as sheet platinum, platinum leaf and gauze, crucibles, capsules, sponge, gun touch-holes, granulated metal, platinum plated on copper and silver, with some preparations and compound salts.

In the French section there are several exhibitors of platinum articles. Messrs. Chappuis Frères, of Paris, show an apparatus which is capable of concentrating 70 gallons of sulphuric acid at once. Messrs. Godart & Labord and Messrs. Desmoutis & Quenessen also exhibit platinum retorts, but we believe all these are soldered on the old system with gold. The last-mentioned firm show a fine platinum nugget from Siberia, weighing 13½ lbs. avoirdupois. Nuggets of this size are very rare, for platinum ore is usually found in grains mixed or alloyed with some rare metals, one of which is iridium, an intensely hard and the least fusible of all metals. Messrs. Johnson & Co. show some specimens of it, one being a cylindrical bar about 4 inches long, the second that has ever been cast and run into a mould. Another specimen of it is a bit that has been cut with diamond powder. This metal forms an alloy with platinum, and we see here some specimens in the shape of gun touch-holes, for which it is well suited. One of them has been used 3000 times, and yet hardly shows a trace of wear. Not to have to return to the subject of iridium, we may mention that the mint of St. Petersburg exhibits iridium as a black powder, and a combination of osmium and iridium (osmiuret of iridium) as a gray powder, along with specimens of platinum in various forms.

RARE METALS.

In one of Messrs. Johnson & Company's cases are to be seen cylindrical bars, an inch in diameter, of some of the rarer metals: such as palladium, 5 inches long; thallium, 6 inches long, looking like iron; osmium, 7 inches long, looking like a stick of charcoal; rhodium, 8 inches long, looking like zinc, only more silvery; cadmium, 8 inches long, looking like lead; also two or three little bits of ruthenium (cast). Thallium, it is well known, was discovered by Mr. Crookes, in consequence of an unknown green line making its appearance in a spectrum produced by burning the residuum of some mineral water. The only other specimen of this metal which we have found in the Exhibition is shown by Messrs. Hopkins & Williams as an angular bar 6 inches long. None of these metals are of much value; but Messrs. Desmoutis and Quenessen, along with some orfèvrerie, as they style it, of platinum, show several articles, such as dinner knives, forks, and salt spoons, made of an alloy of platinum and rhodium. They also exhibit osmium and ruthenium in the form of black powders; as does also the Russian mint, along with iridium and rhodium, in the same form. Both of them show pure palladium; the mint showing a small crucible of that metal. Sticks of pure cadmium are exhibited by Dr. T. Schuchardt, of Goerlitz, in Prussian Silesia, who exhibits small quantities in powder, or crystals, of chromium, titanium, molybdenum, uranium, tantalum, tungsten, tellurium, silicium, and boron. Chromium is shown not only as a black powder, but in small pieces that have been melted, and reflect a dark green colour. This exhibitor has an interesting collection of the acids and salts of the rare metals, such as mellitic acid, tantalic acid, tungstic acid, selenious acid (white crystals), boric acid, osmic acid (pale green crystals); oxides and salts of beryllium and uranium; salts of cerium, thallium, yttrium, erbium, thorium, tirconium, lithium, didymium; fluorides of niolium, titanium, and potassium; tantalum and potassium; vanadiates, selenides, rhodanides, tellurides, &c. Messrs. Johnson have a still more interesting assemblage, which includes silicium and boron (small black crystals, which reflect the light like diamonds), and chromium (cindery-looking lumps in a bottle). We ought to have stated that the cylindrical bars before mentioned form a series of specimens, each weighing 1 kilogramme (2·2 lbs. avoirdupois), of twenty metals, noble, rare, and common, all chemically pure. They have been cast in a symmetrical form, with a view of showing to the eye their comparative specific gravities and their characteristic qualities when cast. It is curious to contrast the platinum bar, some 4 inches long, with the magnesium bar of as many feet. The specimens include the four alkaline metals —aluminium, magnesium, potassium, and sodium. The amalgam of sodium, that is, the alloy of sodium and mercury, is also shown. This amalgam has been applied for the extraction of gold from the ore, with results much superior to those when mercury alone was used as in the ordinary process. Mr. Crookes has patented the new method; and it is stated that, from some Californian ore in which assay found 3576 grains troy per ton, the sodium amalgam extracted 3366 grains, and simple mercury only 1344 grains—a very considerable difference indeed. Magnesium, another of these alkaline metals, although it is only quite lately that it has been separated from its earth in sufficient quantities to come into the market, is now well known to the general public, by reason of its property of burning in the atmosphere, and giving out a light so intense and so pure that it is frequently employed by photographers when they want to illuminate a dark place. The finest specimen of this metal in the Exhibition is an obelisk weighing 11 lbs., which was cast solid in a mould, and is shown by Messrs. Johnson & Co., who also exhibit the metal in the form of ribands, wire, &c. Of the rare metal, iridium, we could only find two exhibitors, Messrs. Johnson & Co. and the Saxon Government; the latter showing, in addition to two small slabs of this tin-like metal made at their Freiberg establishment, a representation of the spectrum produced by the metal in a state of ignition, two broad blue lines, one much paler than the other. So valuable is the collection of metallurgical specimens exhibited by the English firm that they have obtained a second gold medal for it, besides a silver medal for their preparations of nitrate of silver and other chemical products.

SILVER.

Silver, manufactured into a countless variety of forms, is to be seen in every part of the building; but of the unmanufactured metal there is not very much in the Exhibition. The Saxon government has sent from its Freiberg establishment a thick slab, 16 inches long by 5 broad, which has been run into a mould; and the Pontgibaud Mining Company (Puy de Dome) exhibit in the French section a large rough mass of the value of £5400. This was obtained from lead containing silver by means of Pattinson's process, which consists in allowing the melted lead to cool slowly, and keeping it agitated until crystals of lead form and sink to the bottom, leaving the rest richer in silver. This procedure is repeated again and again until the quantity of silver in proportion to the lead becomes so great that the old process of cupellation becomes applicable. By this latter process the combined lead and silver are exposed in a vessel of peculiar form to a strong heat and oxidation, by which means the lead is oxidized and the silver remains in the metallic state. Some other French companies (for example, the Coueron Company and the Vialas Company) send specimens of argentiferous lead ore, and ingots of silver obtained from similar ore. Messrs. Johnson & Co. exhibit some blocks of silver, or silver bullion, as they arrive in England from the mines of Mexico and Peru, previous to passing into the refiner's hands. The two methods in use (viz., by sulphuric acid and by nitric acid) for refining the precious metals are shown, as well as their solutions and precipitations obtained at different stages of the processes until they arrive at the pure state and are ready for the mint. Ingots of refined silver are to be seen—such as are sent to the Indian Mint.

GOLD.

Several of our Australian colonies have sent specimens of auriferous

rocks and earths, but the only nugget of much consequence is a broken one from Queensland, weighing 83 oz. 11 dwts. From New South Wales we have native gold from many of its auriferous districts; and Messrs. Johnson & Co. exhibit a series of specimens of native gold from all parts of the world. The Royal Commissioners of Victoria produce a gilt pyramid. It represents the quantity of gold obtained in the colony for the fifteen years preceding October, 1866; the gross quantity being 1117 tons 15 cwts. 26 qrs., and its value £146,047,444 sterling. The pyramid is 10 feet square at the base, is 52 feet 5½ inches high, and its bulk is equal to 2081½ cubic feet.

MALACHITE.

Malachite, the hydrous dicarbonate of copper of chemists, frequently bears evidence of having been deposited in a clift by the infiltration of water holding metallic salt in solution, but it is sometimes found crystallized in rhombic prisms. There are no specimens of worked malachite in the Paris Exhibition that approach the great doors sent by Russia to the London Exhibition of 1862, or the table that came from one of our Australian colonies. Russia, long famous for her malachite, has, however, sent a fine rough block, measuring 7 feet in length, with a thickness of 2½ feet, and weighing 4523 lbs. This is valued at £3000. Another block, or rather slab, has been sent from Queensland. This measures 4 feet 9 inches by 2 feet 9 inches, but its thickness is not more than a few inches. Malachite is scattered over the Exhibition in numberless forms of personal ornament or house decoration. Perhaps the finest examples of the latter are two handsome vases in the Italian section. They are 2½ feet high, and are composed of small pieces, so carefully cemented together that the junctures are scarcely perceptible. The sum asked for the pair is £480.

GRAPHITE.

The finest show of this mineral is M. Alibert's, whose case stands alone in one of the radiating alleys of the French department. It contains a large collection of blocks and of many ornamental objects delicately carved, the material being obtained from a mine in Mont Batongol in Siberia, near the frontiers of China. There is a still handsomer collection than this, though somewhat smaller perhaps, in the Conservatoire des Arts et Métiers, presented by M. Alibert, along with M. Faber's splendid show of pencils (Bavaria); there is a block of Alibert graphite 2 feet long, so it is to be presumed that he uses the Siberian graphite for the pencils which command such an extensive sale. Faber's business originated in 1761. In 1839 the firm employed twenty workmen, whilst at the present time more than 500 are upon the establishment. Amongst the minerals sent by Russia there are some large blocks of graphite lying carelessly about, and some worked specimens such as bricks and crucibles. Part of this graphite comes from several places in Siberia and part from Finland. South Australia and Canada have sent specimens of graphite, but of very impure quality, some of that from Canada not containing more than from 25 per cent. of graphite. The impurities, however, are easily separated by mechanical means. In that country it has been found in several localities in Laurentian (that is, very ancient) beds, and the quantity seems inexhaustible. Messrs. Eggert & Co. exhibit in the Austrian department a good collection of specimens of graphite from their mines at Mugran in Bohemia. There is a polished block of one cubic foot; a bust of the Emperor of Austria which, with its pedestal, is 2½ feet high; another block in the rough nearly as large as the one first mentioned, and a number of smaller specimens. In the English department the Patent Plumbago Crucible Company of London exhibit along with their crucibles a good many lumps of plumbago from Ceylon. There is also a small case containing lumps and symmetrical blocks of graphite manufactured from the powder of the mineral by Brockedon's patent process, which consists in subjecting the mineral after purification to pressure in a steam press of great power. A single blow compresses the particles into an adherent mass. Messrs. Reckitt & Sons, of Hull and London, have a case with specimens of purified plumbago compressed into parallelopipeds, cylinders, &c. In one of the cases in the United States section there are a few insignificant pieces of plumbago. Graphite consists of nearly pure carbon, with a slight admixture of iron, and its vulgar name of black *lead* is consequently a misnomer. The mine in Cumberland from which we have been supplied for many years being nearly if not quite exhausted, it was highly desirable that fresh deposits of this very useful mineral should be found. The mines in Siberia, Bohemia, and Canada, will, if properly worked, afford all that will be needed for ages. As to the extent of the deposit in Ceylon we have no information.

PARIS EXHIBITION.

We give some further notes of various miscellaneous objects in this Exhibition, objects of more or less interest scattered about the huge building, and which we have taken without any particular order.

TULPIN'S STEAM REGULATOR.

This pressure regulator, the invention of M. Tulpin, engineer, Rouen (Class 59, No. 40), is intended to be placed between steam generators and the apparatus where the steam is to act at a less pressure than that at which it has been produced, and its object is to maintain the pressure of the steam in the apparatus constant, whatever may be the variations of the pressure in the boiler.

The principle of the regulator consists in causing the steam of the accessory apparatus to open or close to any requisite extent a valve situated in the steam passage, when any variation in the pressure takes place. For this purpose the motion of the valve is connected with that of a small piston, on the under face of which the steam acts so that the equilibrium is modified by any variation in the pressure. The apparatus, as in use at the mill of Messrs. Octave Fauget & Co., Oissel, near Rouen, is shown in the annexed cuts, figs. 1, 2, 3, 4, and 5. P is the

Fig. 1.

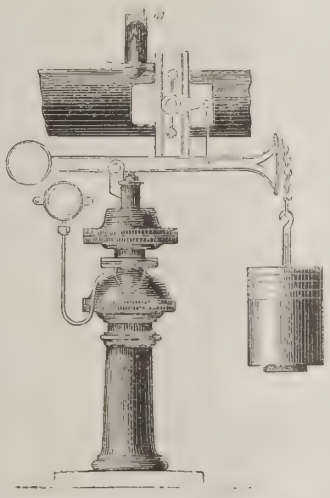
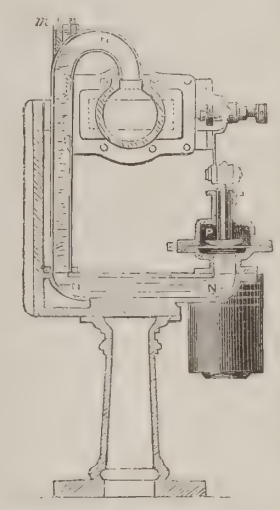
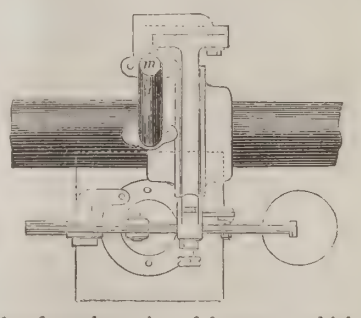


Fig. 2.



piston under which the pressure acts through the medium of the water contained in the elbow pipe, N N, and an india-rubber washer, E, secured between flanches on the pipe and on the cylinder, in which the piston works. The piston loaded to a given weight balances the pressure, until the equilibrium is destroyed by a variation in the pressure of the steam, when the piston is put in motion, followed by the india-rubber washer which, according to the nature of india-rubber, distends and changes its form, and the motion is then transmitted in a very simple manner to the axis of the valve, by which the size of the aperture is immediately modified—reduced if the pressure is augmenting, and increased if diminishing. By varying the weight on the lever, different equilibria will be obtained.

Fig. 3.

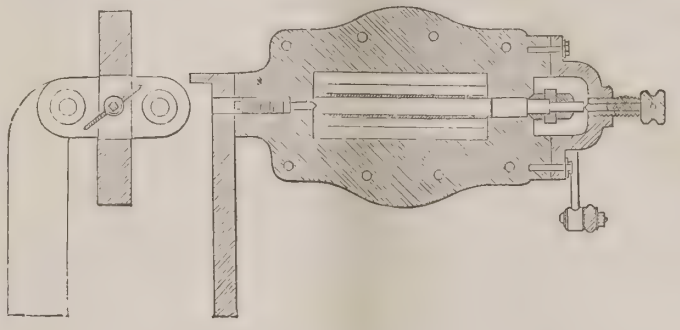


The column of water, N N, which assists in transmitting the pressure, also shields the india-rubber from the action of the steam, which would rapidly deteriorate it. This water does not generally evaporate, as the current of steam is always saturated, and the pipe, N N, is always colder than the steam pipe. It is possible, however, that after the fires are let down the temperature might decrease more rapidly at some point in the circulation of the steam than at the part which incloses the

apparatus, and then a distillation would be liable to take place, conveying all the water to the cooled part. In point of fact this has been sometimes known to occur. Two orifices, *m n*, closed by screw plugs, serve respectively for the introduction of the water and the expulsion of the air when the tube is required to be filled. The supply of water to the tube should be regularly attended to. The india-rubber washers require to be renewed about once a year.

The valve is of brass, and is fixed by pins to its axis; the latter is of steel, and turns on two points (figs. 4 and 5); both the valve and its cast-iron box are rectangular, which form is found to facilitate accurate adjustment. A position of the valve when the aperture is entirely open corresponds to a certain position of the piston, beyond

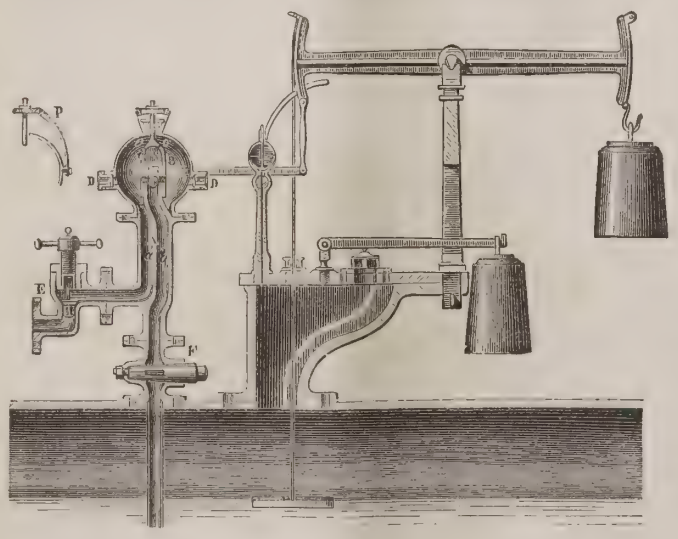
Fig. 4. Fig. 5.



which a stop prevents its further descent, which is the position of rest when the passage of the steam is intercepted. A small steam gauge in communication with the elbow tube, N N, is used to indicate the pressure of the steam, which, though it does not give strictly accurate indications through the motion of the steam, will be sufficiently correct for many operations. Reliable reports have been obtained of the working of this regulator, and it has proved itself a highly useful apparatus, carrying out what it was designed to do, and not requiring great attention. It has, however, been suggested that the safety valve should be combined with it, to render it as complete as it ought to be.

DUTARD'S SELF-ACTING FEED APPARATUS FOR BOILERS.

THE annexed figure shows an arrangement of self-acting feed apparatus for boilers, the invention of M. Dutard, engineer, Decazeville, by which



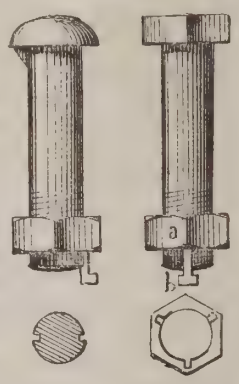
the water is maintained at a constant level, and the mechanism itself so disposed as not to be liable to deterioration by contact with the water or steam in the boiler. The apparatus is fixed to the top of the boiler near the safety valve, and is composed of a column, A, divided into two pipes, one of which, *a*, is in communication with the feed pump, and the other, *b*, descends into the boiler. The water coming from the pump through the valve, E, enters a spherical space formed in the top part of the column, A, and remains there until the water in the boiler sinks below the requisite level. When this takes place the float acts upon the beam to which its rod is attached, and the motion is communicated to a lever jointed to it, the end of which is made in one with the spindle of a toothed segment, F (shown separately in side elevation at the left hand corner of the figure); this segment thus partakes of the motion imparted to the levers by the float, and transmits the same to a pinion into which it gears, and which is attached to a hollow cylinder, *c*. This cylinder has its side perforated with an equal number of tubes of the same size as those formed in the top part of the pipe, *b*. These holes, which, whilst the water is at its proper level, are intercepted by the solid parts of the tube, *b*, now correspond with the holes with which the tube is provided; the water then flows freely into the boiler, the cock, F, remaining open all the time that the boiler is at work, and being only closed when repairs are required.

The valve, E, which is substituted for the ordinary cock, and operates both as a cock and a clack, may also be securely closed in case of repair, by means of the screw shown, in order to intercept the communication between the pump and the boiler. It will be perceived that, in the event of the feed being interrupted by accident from the breaking of a pipe, or any other cause, the clack, E, by falling on its seat, would prevent the escape of the water contained in the boiler. As an additional security, two glazed apertures, D D, are provided in the spherical reservoir, for the purpose of ascertaining at any time that the apparatus is working properly.

This self-acting feed apparatus was applied some months since to the boilers of the Decazeville forges, since which time there has been no variation in the level of water in the boilers. It is applicable also to tanks in which a constant level of water is required.

LUCAS' NUTS FOR BOLTS.

M. Lucas, a French government engineer, has devised a simple means of obviating the loosening of the nuts of bolts, which consists in keying the nut on to the bolt, as a wheel on its shaft. The annexed engraving illustrates this invention. The bolt is shown provided with two slots for the key, and the nut with three, as too many slots in the bolt would weaken it; he therefore adopts the *vernier* principle, giving one slot more to the nut than to the bolt. This arrangement permits of screwing up or unscrewing the nut $\frac{1}{3}$ of a turn only, but by increasing the number of slots greater accuracy may be obtained. The key, *b*, should enter with a little play the slots of the nut, *a*, there being no fear of its falling out, as the nut, having a constant tendency to unscrew itself, presses laterally on the key, and grips it as a vice would; it may be readily withdrawn by slightly turning the nut in the opposite direction. The slots not occupied by the key will serve for the oiling of the threads of the bolt and nut when, from oxidation, the nut cannot be turned.



CHRETIEN'S DIRECT-ACTING CRANE.

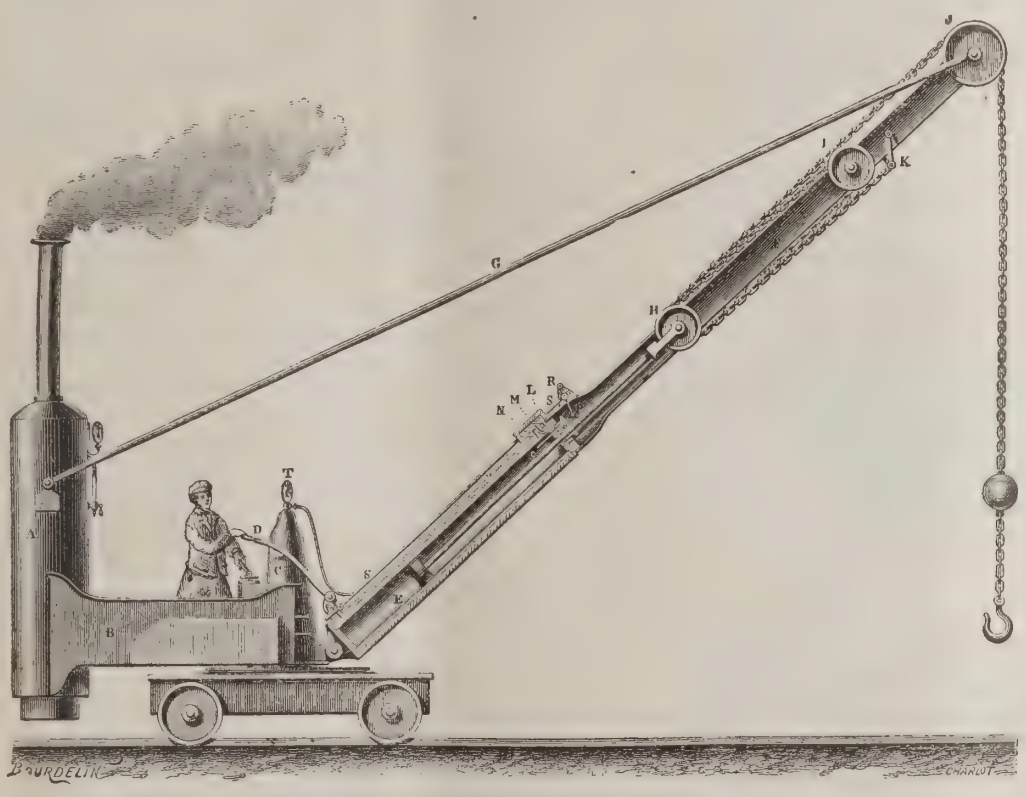
The annexed cut illustrates a crane invented by M. Chretien, and employed at the Paris Exhibition. It is to be seen in the Parc, Class 53, Group 6, No. 225. A steam piston working in a cylinder formed on the jib acts directly on the chain that raises the load, through the intervention of a block and fall, by which arrangement the winch used in ordinary cranes is entirely dispensed with.

The crane is composed of a frame, B, provided with a water tank and coal box, mounted on four wheels, so as to be portable, and carrying at one end the boiler, A, which tends to counterbalance the load, while to its other end is jointed the movable jib. The bottom part of the jib is formed by the steam cylinder, E, the length of which is proportional to the height the load has to be raised; and the rod of the piston working therein is secured at its upper end to two sheaves, H, forming a block and fall. The chain is attached at one end to the jib, and passing over the pulleys, H, and the fixed pulleys, I and J, its other end terminates in the hook to which the load is attached. It will be understood by the arrangement of pulleys shown that the length of stroke of the piston is only one-fourth of the distance the hook has to be raised. The part, F, of the jib which extends upwards from the cylinder is of sheet iron, and its top end is united to the boiler by tension rods, G.

The distribution of the steam in the cylinder is effected automatically by the motion of the piston, which, on arriving at the top of its stroke,

strikes the end of a rod, O P, and raises it, and when at the bottom of the stroke the top part of the rod is struck, which depresses the latter. The rod being connected by an intermediate lever to the slide rods, the valves are alternately opened and closed at the proper time by these self-acting means.

The steam is introduced to the top part of the cylinder, and after depressing the piston, it passes through the upper valve into the space beneath the piston; this action of the steam, however, is not indispensable for the descent of the hook, as the weight of the latter would alone be sufficient; but it is intended to diminish, as much as possible, the cooling of the cylinder, to which, from its great length, it would be liable, and the steam does not escape from the cylinder until, having acted on both sides of the piston, the latter begins to descend to raise the load. A man stationed on the crane regulates the elevation of the load by means of a lever, D; and the horizontal radial motion is produced by the aid of a small fly wheel, which, through the intervention of gearing, causes the cone, C, to turn round a pivot fixed on the frame. A dynamometric apparatus, T, in communication with the cylinder, may be applied to the crane to indicate the weight of the loads raised.



CYLINDRICAL PRESS-FILTER.

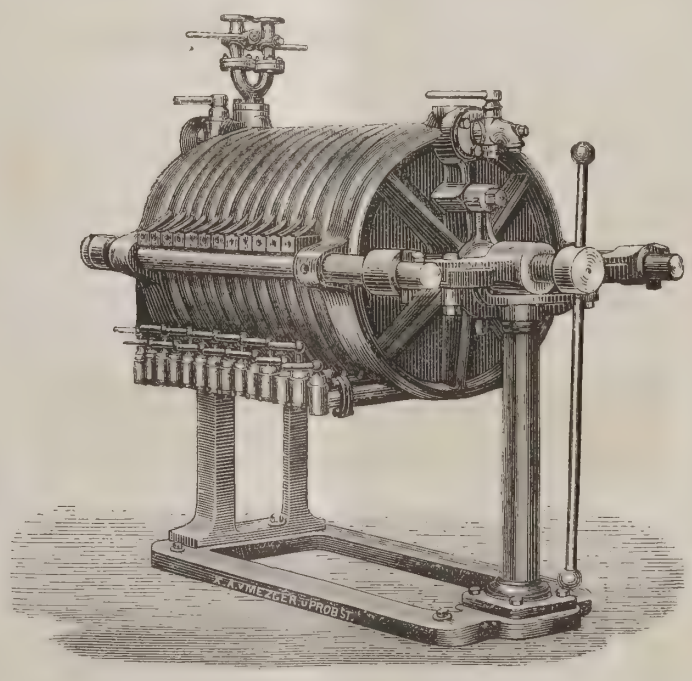
The press-filter is an apparatus the use of which, though now general in all manufactures requiring the filtration of semi-fluid matters, does not date further back than the invention of Needham and Kite, who in 1853 invented a press-filter on the same principle as those now in use, in which the trays were disposed horizontally one above the other, instead of side by side in vertical planes, as in all the press-filters at present in use. Since that time the press-filter has been rapidly improved by numerous manufacturers, among whom Messrs. Du Rieux et Roettger, who have applied themselves with much success to the perfecting of all kinds of apparatus employed in sugar refinery, have given it their attention, and the annexed engravings are perspective views of the cylindrical press-filters such as they now make for the treatment of the deposits of sugar refineries. Several of these presses are shown in the French Annex (Class 50, Group 6).

This arrangement is composed of a series of circular trays arranged vertically side by side, and which are provided with lugs resting on the lateral shafts. These lugs are intended to sustain and facilitate the sliding of the trays, whilst admitting of their being taken off when necessary. At one end of the apparatus is a strong fixed disc, and at the other end a similar but movable disc, which is manœuvred by means of a vice screw supported in the cross piece which unites at this end the two lateral shafts of which we have just spoken.

All the trays between these two discs constitute so many filters for the extraction of the clear juice from the scum, and each is composed of a cast-iron box, provided with grating bars, on each face of which is placed a perforated metal plate covered with filtering cloth or wire gauze. The juice to be filtered is introduced under pressure, by means of a pump or similar apparatus, into an oval conduit, formed in the solid part of the tops of the trays so as to avoid cutting into the wire gauze, and enters the different compartments formed between the filtering surfaces of two adjacent trays, whence, by the effect of the pressure, it passes through the wire gauze that forms the sides of the compartment into the grated space situated between the two wire-gauze partitions of one tray, each of which spaces, comprised on the one hand between the two bars of this grating, and, on the other hand, between the two wire-gauze partitions, constitutes a separate compartment. The filtered juice escapes through a hole made in the bottom of each compartment into a circular collecting culvert made in the interior of the box, and thence into a horizontal pipe under each tray, provided with a cock, as shown in the figure.

The method adopted for fixing the filtering gauze is claimed as new. The wire gauze is stretched upon an iron ring, inserted in a groove formed in the box, so that the wire gauze rests upon the perforated plate fixed to the grating, where it is firmly secured by a couple of screws.

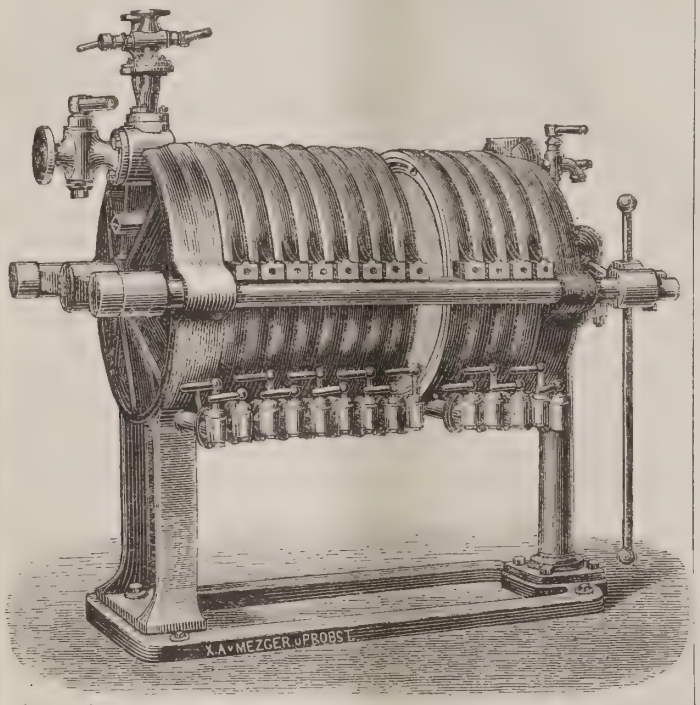
At the commencement of the operation the juice is but gradually introduced. When the filtered juice ceases to run off through the lower



cocks, it is a sign that the cakes are completely formed and hard; the introduction orifice is then closed and the steam caused to enter through one of the adjacent U-shaped tubes shown in the engraving, for the

purpose of removing the juice contained in the arrival conduit which traverses the trays, and expelling it through the cock opposite the introduction orifice, which up to that time had been kept closed; the vice-screw is then loosened, and the movable disc and trays are slid along so as to cause the cakes formed, which are not quite an inch in thickness, to drop out; and, if necessary, the trays are relocked and the wire gauze cleansed by the introduction of water through the second branch of the breeches pipe, and the operation recommenced.

If the scum be too thick it may be diluted with boiling water, or if it adhere to the filtering wire gauze it may be mixed with dry ashes, lime powder, or fine sand. A receptacle for the juices is placed beneath



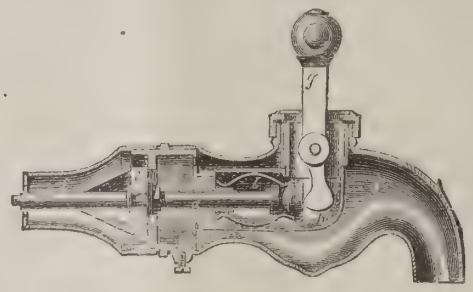
the cock, and a tray under the boxes to catch and guide into the receptacle any juice that might escape through the joints, which tray is removed when the cakes are discharged.

By means of the above arrangements all the sugar is extracted from the scums left from the operations of defecation and evaporation, which were before sold cheaply to distillers, and which were completely lost in the colonial sugar refineries.

Messrs. Du Rieux et Roettger are also inventors of a system of strainer, the object of which is to render continuous the action of the press-filters, by eliminating from the juices, or syrups, or inferior products that it is required to filter, all the organic remains which might impede the flowing of the former, obstruct the clacks of the pump, and stop up the tubes or cocks, and which, impelled by the pressure in the press-filters, might present obstacles to the introduction of the matters to be pressed. This apparatus consists of a perforated sheet-iron bucket, supported in a cast-iron vase by two lugs, with which the interior of the latter is provided, there being a free space between the two vessels for the circulation of the strained juice. The matters are introduced through a pipe opening into the top part of the cast-iron vase, and the strained juice is run off through a pipe at the bottom leading to the press-filter; when the holes in the bucket become clogged the cover of the vase is unscrewed, and the bucket withdrawn to be cleansed, and another inserted in its place.

CHOUET'S NEW FORM OF COCK.

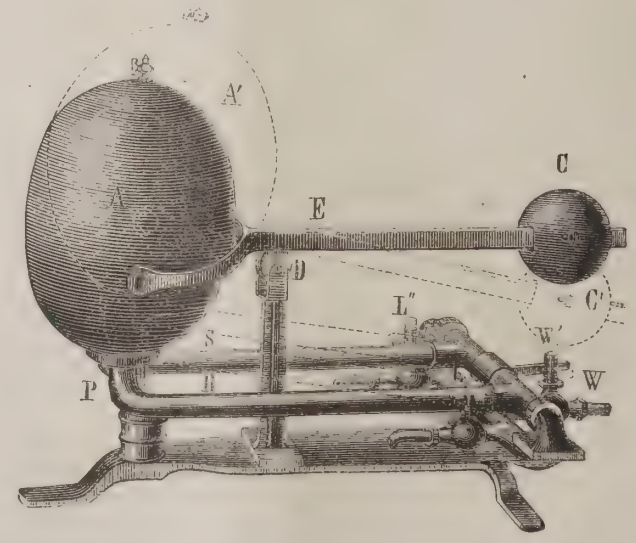
The annexed cut exhibits a section of a cock recently patented by M. Chouet, manufacturer, of Paris, the object of which is to obviate the ill effects of the pressure on the pipes at the time of the closing of the cock; this is obtained by the addition of a receptacle into which the water is introduced, and from which it escapes freely, when the cock is closed, through a number of holes constantly open. This cock also possesses some further peculiarities, which we shall briefly describe:—The receptacle intended to obviate the pressure is formed of a metal box, *b*, the top face of which acts as a seat for a valve, *c*, inclosed in the body of the cock. The water which enters this receptacle runs off through a series of holes, *e*, made in its front face. Since these are constantly open, the water contained in the receptacle can always escape when the cock is closed, by which means the excessive pressure thrown on the cock and pipes, in the common form of cock, is avoided. The valve, *c*, is also made conical in form as shown, in order that, by



presenting less surface to the resistance of the water, it may be pressed less forcibly on to its seat. The cock is secured to the water pipe by a junction piece, *f*, which is screwed on to the top part of the receptacle, *b*, and carries at its end a grating for the purpose of retaining any impurities which might be carried along with the water, and also to act as a guide for the tail, *d*, of the valve, *c*. The valve is actuated by means of a lever, *g*, and kept on its seat by a spring formed of a piece of india-rubber tubing, maintained by two bands, which arrangement is inexpensive and almost indestructible. In order to obviate the effects of the liquid acting on the spring and on the mechanism of the cock, the whole is inclosed in a sort of sheath, one end of which is screwed on to the receptacle, and the other end on to a small vertical cylinder carrying the axis of the lever, *g*. A leather washer, pressed by a screw formed on the cock, makes the joint tight, and prevents the entrance of the water into the sheath inclosing the mechanism.

RIEDEL'S SELF-ACTING FEED APPARATUS FOR BOILERS.

The annexed cut represents an apparatus for feeding boilers, a drawing of which is exhibited by M. Riedel, in the American Section, Class 53. Its object is to dispense with the use of a force pump or



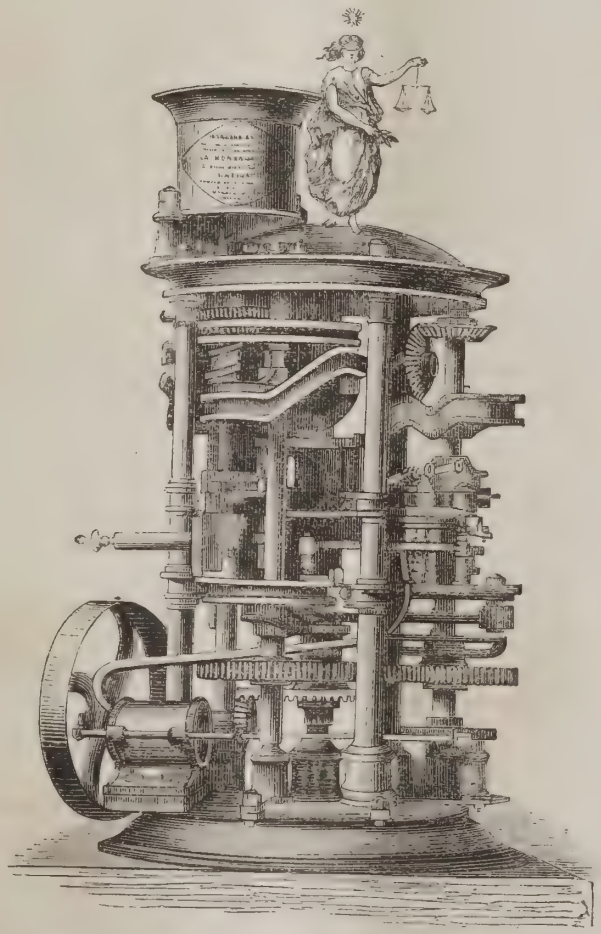
injector, and to maintain the water in the boiler constantly at the same level. It, moreover, serves to measure accurately the quantity of water introduced into the boiler in a given time. The receptacle, A, is jointed to a lever, E, having its fulcrum on the roller, D, and carrying a counterweight, C. To the bottom of it are attached two pipes, B and S, which are united by the cross pipe that serves for communication between the pipes, S and W. The steam pipe, S, takes its rise at the top of the intrados of the dome of the receptacle, A, and goes down to the level of the water in the boiler; the feed pipe, B, proceeds from the bottom of the receptacle, A, to the boiler, which it enters below the water level; the pipe, W, is in communication with a reservoir, and supplies water to the receptacle. L' L'' and W', are valves; I, an

air cock, and P, a piece intended to deaden the shocks which may be produced during the working of the apparatus. It acts in the following manner:—The cock, I, being opened, the receptacle, A, is filled with water from the reservoir, and takes the position shown in the cut, after which the cock is closed. It is then in communication with the boiler by means of the valves, L′ and L″, of the tubes B and S, the valve, W′, being closed. If then the water in the boiler descends below its proper level, the steam passing through the tube, S, enters the receptacle, A, and fills it, forcing the water which it contained into the boiler. The receptacle then, being relieved of the weight of water, rises to the position shown by the dotted lines; the valves, L′ and L″, are closed, and the valve, W′, opened, which brings the receptacle, A, in communication with the reservoir; the steam in the receptacle being condensed, the water again enters it and brings the apparatus into its former position, with the valves, L′, L″, open, and the valve, W′, closed, and this is repeated as often as the water descends below the required level.

CIGARETTE-MAKING MACHINE.

M. de Susini, the proprietor of a cigarette manufactory at Havannah, exhibits at work (in the French Section of the main building, Class 60, Group 6, machines and tools) a machine for the manufacture of cigarettes, of which the annexed engraving is a general view.

M. Susini's cigarette works, though established only twelve years



since, produce 3,000,000 cigarettes per diem, and 2500 workmen are employed, amongst whom there is not one slave.

The machine measures only 19½ inches in diameter by 30½ inches high, and yet it is capable of making 60 cigarettes per minute, or 86,400 per day. It thus performs the work of twenty-eight men employed ten hours a day. The following is the principle of the machine:—The pieces of paper, intended to form the exterior of the cigarettes, are previously cut to the proper size and arranged in packets by hand, and are drawn into the machine by means of exhausted air; but a special mechanism, simple and easy of application, permits of the use of continuous paper prepared in rolls. The paper tube being made, the machine rams in the tobacco with great regularity, and the cigarette is thus formed according to the Havannah mode, the paper being simply rolled, without any longitudinal gumming of the edge, but this may be effected by a slight modification. The ends of the cigarettes are folded in the Havannah style, by means of an arrangement which exactly imitates the operation performed by the workman with one of his nails, and the name "La Honradez," that of the manufactory, is then dry-stamped on the cigarette.

By merely changing one of the platforms and enlarging the mould, the diameter of the cigarettes may be increased. The cigarettes issue from the machine in a perfectly cylindrical form without *belly*, to use the technical expression, not an atom of tobacco gets in between the folds of the end, or the double or twist of the paper; but the tobacco is equally distributed, and at the desired pressure in the cigarette.

The inventor is now constructing a new machine to register by self-acting means the number of cigarettes produced, and in which an electric signal is to give warning when the supply of tobacco and paper is nearly exhausted.

CONVEX WEAVING.

The Convex Weaving Company of New York exhibit an automatic loom (American Section, Class 56), constructed under the directions of Mr. Opper, for the weaving of stays and other "convex" goods. The company state that it answers perfectly well in the performance of its work, and that it will turn out forty pairs of stays a day, whereas not more than four pairs can be made in a hand-loom.

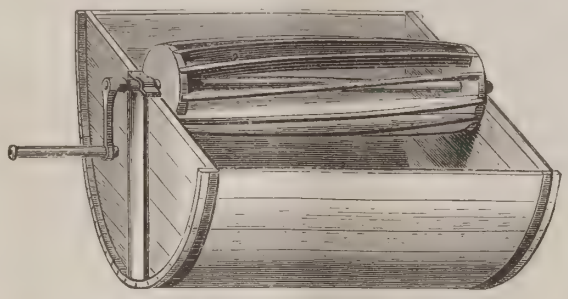
The principle of a constant length of travel for the shuttle was adopted for the sake of simplicity, but as it is necessary in weaving the gores that the weft thread should pass through only a part of the breadth of the warp, the Jacquard has been employed for the purpose of taking up the portion of the warp required to be woven in that part. As the shuttle always passes over the full breadth of the warp, of which only one portion, say one-third, is to be used, it unwinds the full length of weft thread from the bobbin, but only one-third of it is tied in the warp. In repassing the shuttle one-third more is tied, thus leaving one-third of the unemployed weft thread in the form of a loop upon the article manufactured. To remove this superfluous thread, the thread catcher, which is a lever with an elastic finger, passes from behind, through the lay on each side of the reed, and pulls the thread out. In consequence of this partial opening of the warp, the fly shuttle could not be used, and another contrivance had to be resorted to. This consists in a carrier, by which the shuttle is conveyed to the centre of the warp, where it is taken by the other carrier and passed through the warp. By these carriers a very even motion, free from all sudden jerks, is imparted to the shuttle, so that the the finest silk and the loosest wool can be worked as neatly and easily as by hand, without the least danger of breaking the thread, as would happen with the fly shuttle.

The most difficult part of the work is performed by the *regulator* or *take-up motion*, the action of which is to take up the woven cloth in such a manner as to leave a straight line in front of the reed. As the cloth is woven, first, only on one side; secondly, for the whalebone pockets, where the cloth is double, evenly over the full breadth; thirdly, on the other side only; and finally, for the full breadth at the back and front of the stay—the motion of the regulator must change accordingly. To effect this, the cloth passes between two sets of rollers, the upper of which are simple pressure rollers to be regulated by springs and set-screws. The lower rollers are fluted and worked by a system of levers independent of each other. The levers are worked conjointly by the Jacquard, and lay, so that the lay gives only a movement to those levers which have been previously acted upon by the Jacquard. A very elastic warp tension is obtained by a peculiarly constructed lever combined with an elastic break, so as to render the whole machine fit for any kind of work, flat or convex, plain or richly ornamented, according to the cards placed upon the Jacquard, and the material put in warp and shuttle.

AGITATOR FOR TAN VATS.

M. B. Choureaux, cooper, of Paris, has recently patented a new description of agitator, shown in the annexed figure, which, simple as it is, will probably be found of considerable use in the operation of tanning. The blades of the agitator, instead of being made parallel to the axis, are inclined; whatever be the form of the vat to which such an agitator is applied, a motion is imparted to the water which facilitates

the combination of the tannin with the hides, without injuring their substance, or throwing the liquid out of the vat. The apparatus shown in the figure is intended to make from twenty-five to thirty revolutions per minute; it admits of eight blades, all of which should not be immersed



at the same time in the liquid, as this arrangement facilitates the rotatory motion, and lessens the amount of motive power required. If the vat has an oval form, two agitators placed end to end with the blades inclined in opposite directions may be employed.

THE RICHARDSON PROCESS.

During the past month, and therefore subsequent to the writing of our former paper on this subject, some specimens of the metal produced by the Richardson process have been submitted to the working test at Parkhead. The iron, as we predicted last month, was found totally different to Bessemer metal, being neither *hot short* nor *cold short*, so that if phosphorus is really the cause of cold shortness in iron, we may be pretty sure that in the Richardson process the phosphorus is altogether eliminated, or present only in a very small degree, apparently too small to produce any sensible effects. From the letters we have received, and the inquiries made concerning the new process, it is evident that the iron makers and users are alive to its value.

Some of our readers may possibly have seen a leader on this subject, criticising our former paper, in the pages of *Engineering*, the author of which endeavours to show that the process is an infringement of Mr. Bessemer's patent of December, 1855. Now we have examined Mr. Bessemer's specification, and we are of opinion that the two processes are not only totally dissimilar, but what is more, their objects are equally so.

The writer of the article in *Engineering* endeavours to show that the tubular rabble which Mr. Richardson employs is nothing more nor less than a "blast pipe," and takes us to task for calling it otherwise; we have merely to add, that not only is the tubular rabble used to inject oxygen into the mass, but it is also used whilst the oxygen is being injected, for stirring about and exposing fresh surfaces of the charge to the decarbonizing action of the reducing flame, precisely in the same manner as the common rabble is used.

If Mr. Bessemer's patent of 1855 covers a process similar to Richardson's, what has Mr. Bessemer been doing all these years since? The fact is that Mr. Bessemer's patent of that date is, we believe, impracticable; if so, we need say nothing more as to the validity of a patent possessing that feature. And further, not only does it appear from the specification that Mr. Bessemer had no idea of doing away with the refining of iron prior to puddling, but he also makes no mention of converting crude or pig iron in the puddling furnace by using a tubular rabble to inject oxygen into the mass, at the same time stirring the mass about by it, as with an ordinary rabble. On the contrary, Mr. Bessemer specifies the construction of a furnace in which the air may be blown in through *fire-clay lumps*, *stirring the metal about all the time with an ordinary rabble;* a plan, as we have said before, that appears to be impracticable. Even yet we have further proof that Mr. Bessemer never had any idea of not only doing away with the refinery, or of using a tubular rabble for assisting the conversion of crude into malleable metal; this was suggested to Mr. Bessemer by an American engineer, Mr. Zerah Colburn, about two years ago—at least we have Mr. Colburn's letter to show this.

Mr. Bessemer certainly is not the man to adopt the credit due to others. If he had produced such metal on a profitable scale as that about which we have written, would not all the world have heard of it? If the process was worth anything for making bar iron, it is singular that it was not carried out at Govan or somewhere else. Mr. Bessemer unquestionably deserves, and we are amongst those who heartily wish him all he can receive for the great part he has acted, but it is well known that he does not get the credit of having produced such iron as is regularly made by the old-fashioned, nevertheless barbarous, process of puddling.—V. D.

PARIS EXHIBITION.

PORTABLE ENGINE.

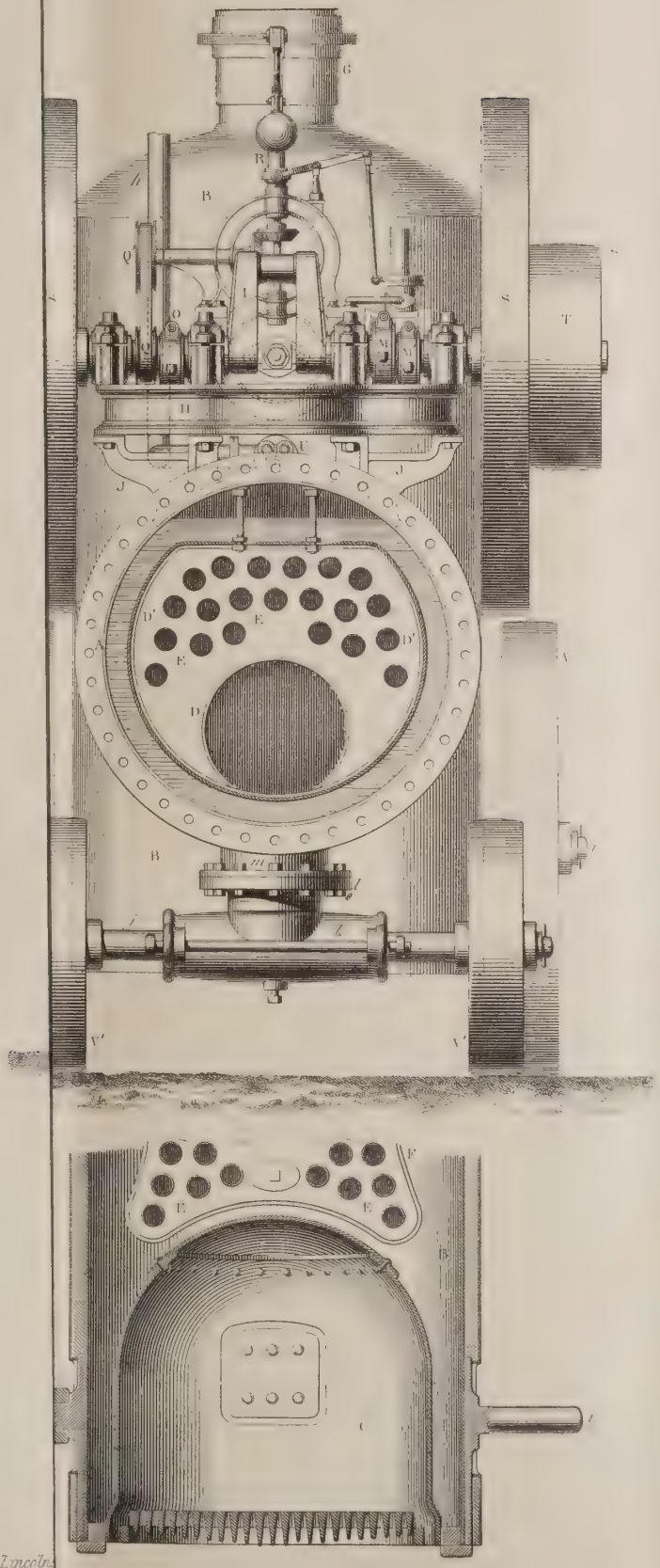
(Illustrated by Plate 10.)

We translate the following description of a portable engine constructed by M. Isidore Nillus, jun., of Havre, and exhibited in the Paris Exhibition, from the *Publication Industrielle* of M. Armengaud, to whom we are also indebted for the accompanying plate engraving. Fig. 1 is a sectional elevation of the engine and boiler; fig. 2 is a transverse section viewed from the opposite end to the fire-box; fig. 3 is a plan of the engine detached from the boiler; fig. 4 is a transverse section taken across the centre of the furnace and hind wheels; and fig. 5 is a horizontal section of the cylinder and valves with their cast-iron jacket.

In order that our readers may be made acquainted with the objects which M. Nillus has had in view in adopting the present combination, we shall give his observations on the defects of the ordinary arrangements. It is well known that the necessarily limited dimensions of these engines renders difficult the use of a boiler to which a sufficiently large furnace may be adapted, and in which a sufficient amount of heating surface may be obtained without adding to the draught of the fire to such an extent as would tend to increase the consumption of fuel and rapidly deteriorate the boiler itself. M. Nillus also states that in the mounting of the mechanism and the boiler considerable difficulties are met with in isolating the mechanism from the boiler, in preserving it from the effects of the excessive heat, and in making it of the requisite strength. In order to meet the first objection, that of deficiency in heating surface, M. Nillus has adopted the method of return flues used in marine boilers, placing the smoke-box at the same end as the furnace. The boiler is composed of a horizontal cylindrical body, A, united to another vertical body, B, the lower part of which contains the fire-box, above which it is extended to a sufficient height to form a capacious steam-chest. The furnace is composed of steel, and is of a cylindrical form; it communicates with a flue, D, the opposite end of which opens into a circular chamber, D′, communicating by means of the tubes, E, with the smoke-box, F, somewhat of the form of a trapezium, and thence with the chimney, G, which traverses the steam-chest, B, of the boiler. The whole of the furnace, boiler, tubes, and combustion chamber is surrounded with water, and constitutes the heating surface; the chimney, by passing through the steam-chest, dries and superheats the steam. It is worthy of observation that every cubical form is avoided, in order to obviate the necessity for using stays. All the internal parts are accessible for the purposes of cleaning by ordinary man-hole doors placed in convenient positions. The main body of the boiler is closed at the opposite end to the fire-box by a movable plate, A′, bolted on, and which may be removed for the inspection of that part of the boiler.

The working mechanism, in addition to the special arrangement by which its isolation is effected, possesses all the peculiarities of engines of the most approved construction. The frame or plate, H, on which all the other parts exclusively depend, is specially adapted for this class of engines, which does not admit of external bearings for the driving shaft; it carries four plummer blocks (shown in plan, fig. 3), between which the various accessory parts of the mechanism are contained. The arrangement of the plate is further distinguished by the cast-iron brackets, J, which support it at a sufficient height from the boiler to prevent the working parts being affected by the heat of the latter.

It is not necessary to enter into all the details of the engine, but we must draw attention to the valve arrangement, which has all the advantages of a variable expansion. The valve is on the Meyer system, in which the steam-box, N, contains an ordinary slide, *a*, perforated and provided at the back with two slides, *b*, screwed on to the spindle, having a right and left hand screw thread cut on it. This spindle, as is well known, receives an alternate motion from an eccentric, M′, mounted on the shaft, I, near to the slide eccentric, M, and the degree



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PARIS EXHIBITION.
14 H.P. PORTABLE ENGINE.
ISIDORE NILLUS JUNR ENGINEER.
HAVRE.

Fig. 1.

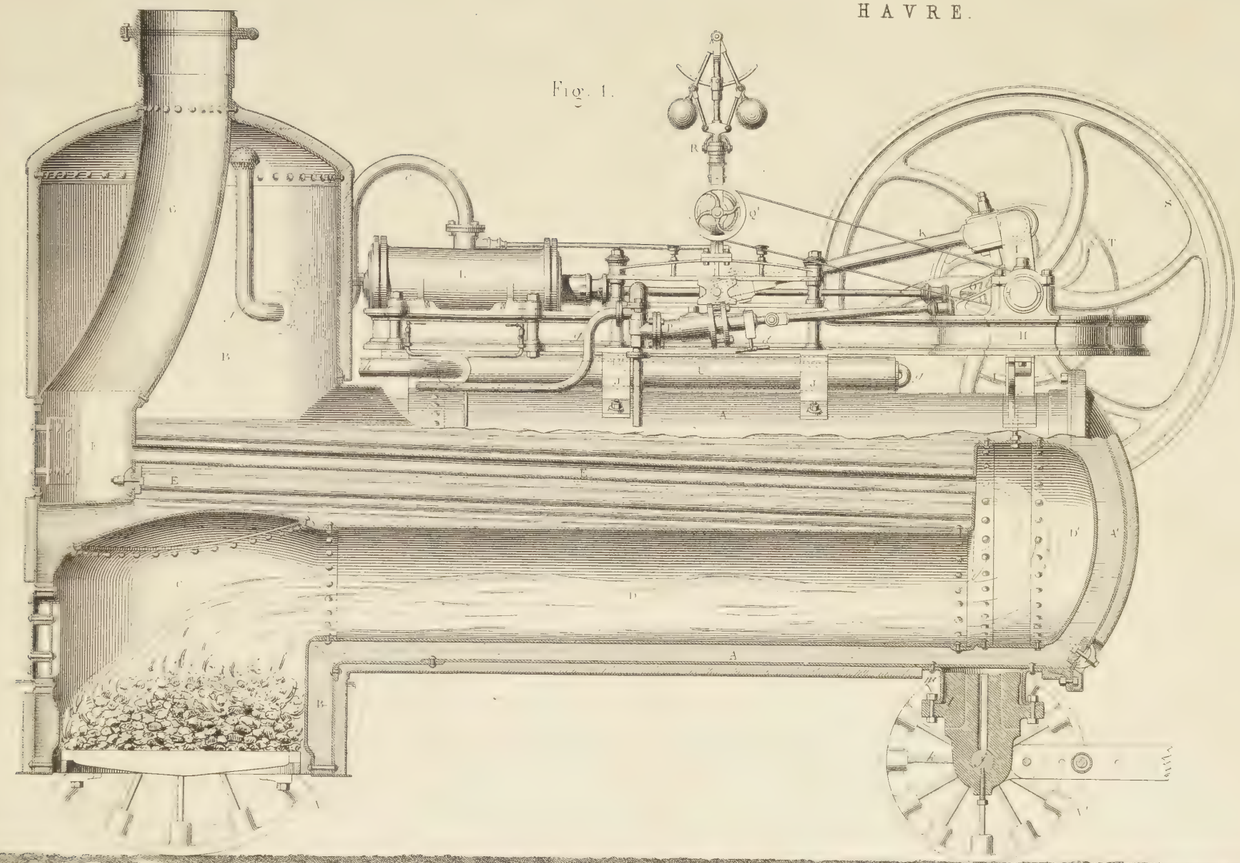


Fig. 2.

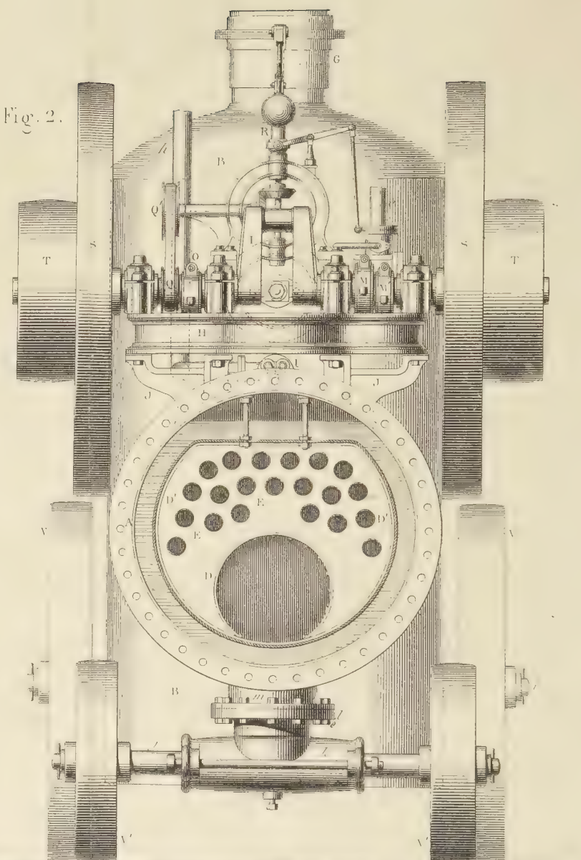
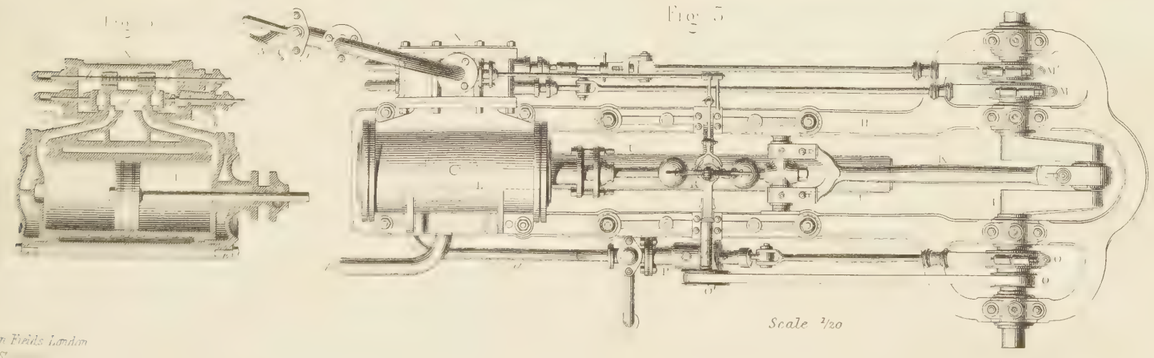
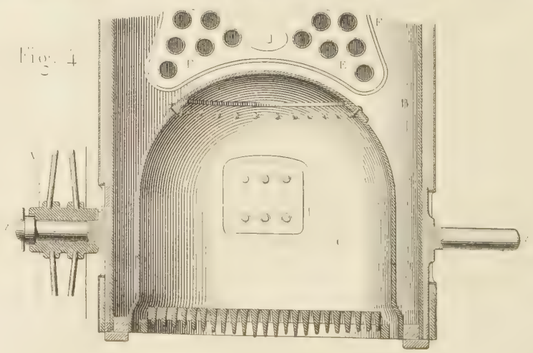


Fig. 3



Scale 1/20

Fig. 4



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of admission of the steam at full pressure is modified at will by changing the position of the slides, *b*, on their common spindle. This is effected, even while the engine is at work, by turning the rod by means of a handle, *c*. The shaft carries at its other end a third eccentric, O, actuating the feed pump, P, which, like the other parts, is secured to the foundation plate, H. The connection between the plunger and the rod of the excentric is effected by means of a pinching screw, *d* (fig. 1), which permits of its being disengaged when the feeding is required to be suspended. The governor, R, is actuated by a strap which passes over two pulleys, Q and Q′, and its standard is fixed directly on to the piston-rod guides. The shaft also carries two fly-wheel pulleys, S, and two pulleys, T, of less diameter, according to the speed to be transmitted.

We shall now refer to the relation between the boiler and the mechanism with respect to the supply and escape of the steam, as well as to the feeding, which in this engine is specially noteworthy. The steam is conveyed into the slide-box by a pipe, *e*, which rises from the slide-box, and taking a curved course again, descends, and is attached to a cock, *f*, on the steam-chest, and in communication with a vertical pipe, *f′*, terminating in a rose. The position of the cock, and the form of the pipe, *e*, are so combined as to prevent the carrying away of the water or the return of the condensed steam into the slide-box. The escape of the steam is effected in the ordinary manner by a hollow zone or belt on the cylinder, L, and connected with a pipe intended to conduct the steam into the chimney; but in this arrangement the passage first communicates with a cylindrical chamber, U, situate underneath the base plate, the object of which is to heat the feed water. The tube, *g*, through which the feed water is pumped back into the boiler, passes to and fro along the receptacle, U; the escape steam consequently surrounds it, and after being deprived of a part of its heat, escapes through the exhaust pipe, *h*, into the chimney.

The engine is mounted on four wheels, the hind two, V, being mounted on axle journals, *i* (fig. 4), forged in one with a plate, which is rivetted on to the fire-box. The small fore wheels, V′, are also mounted on an axle, *j*, passing through a cast-iron socket, *k*, carrying the connecting bolt of the coupling. The socket operates as a fore-lock of a carriage, and is therefore provided with a gudgeon capable of adjusting itself in a coupling box, *l*, which is bolted to a flanged bush, *m*, rivetted to the boiler. The crown and nave are cast in one, with wrought-iron spokes.

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RECENT PATENTS.

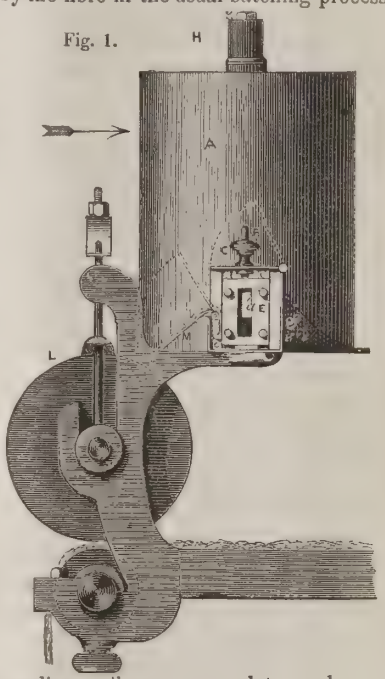
TREATING AND SPINNING JUTE, HEMP, FLAX, AND OTHER FIBROUS SUBSTANCES.

WILLIAM TAYLOR.—*Patent dated 26th November*, 1866.

THIS invention relates to the lubrication of the fibres of jute, hemp, flax, and other fibrous substances, for the purposes of manufacture, and to a peculiar construction of apparatus applicable to the lubrication of fibrous substances at any stage of their manufacture; also to certain improvements in the machinery or apparatus employed in spinning fibrous substances.

The lubrication herein referred to is not intended to supersede or interfere with the usual process of "batching" jute, whether this be done by hand or by a special machine for the purpose, but is intended to be additional or supplementary thereto; and this part of the invention consists in imparting to the fibres (after they have been broken down, or partially broken down by the action of any of the well-known preparing machines, and formed into a sliver) a quantity of lubricating material, such as oil, either in a pure state or combined chemically with water by means of an alkali, the amount of lubricating material so applied being either retained from the "batching" process, or it may be entirely in addition thereto, as may be desired. It is considered that the portion of lubricating material so applied will be more useful and effective in the after processes of manufacture, particularly the drawing, roving, and spinning, as it will be fresher and more on the surface of the fibres than if applied and absorbed by the fibre in the usual batching process.

Fig. 1.

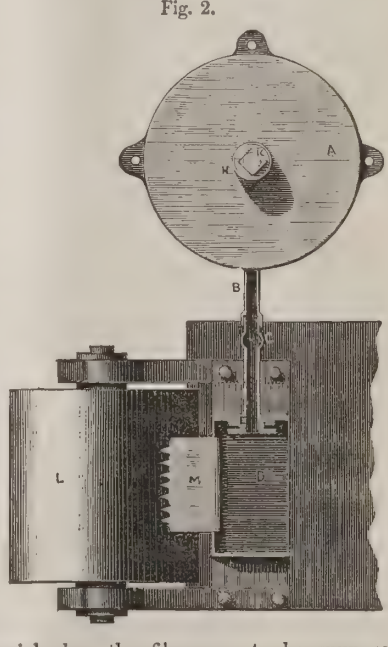


The improvements in machinery or apparatus for spinning the fibrous substances, hereinbefore referred to, consist of two parts. The first part refers to the spindles of the spinning frames, and has for its objects the securing the step and collar bearings effectually in their places, whilst retaining, at the same time, perfect facility for adjustment, and affording facility for allowing the spindles, of whatever length they may be, to be removed from or replaced in the frame without moving the rail or loosening its fastenings. The second part of these improvements has reference to that part of the spinning frame called the "bend," which holds the bearings or journals for the drawing and retaining rollers, the intermediate roller, or rove plates and conductor rod.

Fig. 1 of the accompanying engravings represents a side elevation of the improved lubricating apparatus, as applied to the delivering rollers of a jute card, and fig. 2 is a plan corresponding to fig. 1.

In carrying out the first part of the invention it is proposed to employ a peculiar apparatus, which is called a "pneumatic fountain," the object of which is to give out and impart any required quantity of the lubricating material in a uniformly regular manner. This lubrication is equally applicable to the fibrous substances named, whether they are in the state known as line, or in the state known as tow, each requiring a somewhat different class of machines for their manufacture. In the case of flax, where no lubrication of the fibre in the process of spinning or manufacture has hitherto been practised, the lubrication itself forms an essential feature of the invention, as well as the mode of applying the lubricating material. The mode of applying the lubricating material when the fibres are to be spun or manufactured from the state in which they are known as tow, consists in applying it to them whilst they are passing, or after they have passed, over the breaker or finisher card or both, and have been formed into a sliver, by means of rollers specially made for applying the same, or by using some of the rollers of the machine itself for that purpose. When the fibres are to be spun or manufactured from the state in which they are known as line, the lubricating material is applied to them at the spreading or drawing frames by means of special rollers, or by using some of the rollers of the machine itself for that purpose.

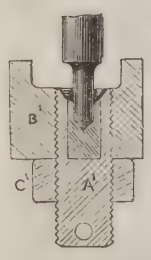
Fig. 2.



The "pneumatic fountain" consists of a closed vessel, A, which holds and supplies the lubricating material. To the lower part of one side of this vessel there is fixed a passage, B, and cock, C, in position to drain it into a small reservoir, D, forming part of the fountain. This passage and its cock has a waterway of a rectangular section, the long way of the rectangle being vertical and the short way horizontal. The end of this passage, where it enters the small reservoir, is provided with a slide or sluice, E, so as to make a perfectly air-tight joint. In the top of the fountain there is an orifice through which to fill it; this orifice being made to close air tight by a screwed plug and head or cap provided with a leather rubber or washer, and is made so as to be easily opened and closed.

The small reservoir, D, is made to overflow upon the lubricating rollers, L, by means of a projecting flap, M, hinged to the reservoir, and which can be elevated or depressed as desired (see dotted lines in fig. 1), or a communication is made between the reservoir and rollers by means of a piece of woollen cloth, sponge, or other porous or absorbent material laid over this flap, as shown in fig. 1, and the lubricating material is thus transferred to the rollers, L, by capillary attraction as required, the rollers giving it off to the sliver of fibres passing through them. This hinged flap serves two purposes: firstly, when turned up into the reservoir it prevents the discharge of the lubricating material when the machine is stopped, and secondly, it can be readily raised for a moment to clean away any dust that may accumulate between the cloth and the roller, or it may be depressed or elevated to carry over more or less of the lubricating material. The operation of the fountain is as follows, viz., the slide, E, over the orifice of the passage being adjusted to give the required level of the lubricating material in the small reservoir, D, necessary to give off the required quantity, the cock, C, is closed, and the filling orifice at H opened; the fountain or vessel, A, is then filled with the lubricating material, and the orifice again closed air tight by the plug and cap. In this condition the atmosphere is excluded from the fountain, and can only enter it by opening the cock, C, of the passage; the cock is then opened, when the lubricating material flows into the reservoir, D, and the air enters the fountain. This continues until the lubricating material covers the orifice, when, by a well-known law, no further flow will take place; but in proportion as the reservoir overflows or transmits the lubricating material to the rollers an equal quantity will flow from the fountain to maintain the adjusted level in the reservoir, and when the machine stops the cock, C, of the passage is closed, and the projecting flap, M, is raised to a vertical position or turned back into the reservoir by the hand of the attendant, when the supply will be stopped, or the cock, C, can be opened or closed and the projecting flap elevated or depressed automatically by the machine itself.

Fig. 3.



Instead of applying the lubricating material by means of rollers it can also be applied by forming the overflow part of the small reservoir with a number of small holes, or by points by which the lubricating material can be made to drop upon the sliver of fibres as it passes below. It is obvious that the "pneumatic fountain" is equally applicable for regulating the supply of lubricating material to the fibrous substances named at any part of the manufacturing process, or whether they are in the raw state, in broken fibre, yarns or cloth.

The second part of the invention has reference to the securing of the step and collar bearings of the spindles of spinning frames. According to this invention holes are prepared in the rails for the footsteps and collar bearings in the usual way, after which the hole for the footstep is screwed with an internal thread of any desired pitch or fineness, as shown at fig. 3, and the cylindrical step itself, A′, is screwed on the outside to fit this hole, and is made of sufficient length to pass through the rail, B′, and take in to a jamb-nut, C′, below, a small hole being bored through it at the lower end in the direction of its diameter, so as to admit a movable pin or lever to be inserted in it by which to screw it round when required. The footstep is then screwed into the rail by means of this movable pin or lever, until it is in proper position for the spindle; the jamb-nut, C′, is then screwed up upon it tight to the bottom of the rail, B′, when it will be so effectually secured in its place that it will not move. The spindle is thus kept at its proper level in reference to the traverse or coping rail, and will in consequence cause no derangement in filling the bobbin by falling down from its adjusted position; and when adjustment is required for wear or any other cause it is obtained more correctly than with the pinching screw heretofore employed, by slackening the jamb-nut, elevating or depressing by turning the footstep round as required, and tightening the nut again when the adjustment is made.

For the collar bearings a slit, *a*, is cut from the front of the rail to the hole prepared for the collar, through its whole depth, a little wider than the diameter of the barrel of the spindle, as shown in plan and vertical section at figs. 4 and 5, so that it can pass through this slit; a

Fig. 4.

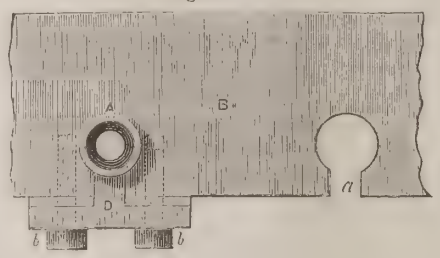
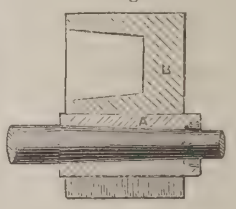


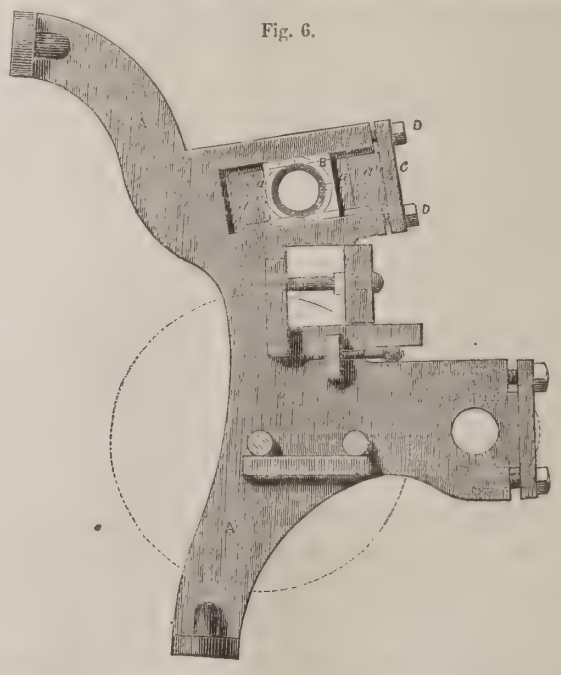
Fig. 5.



small bracket, D, is made to fit into this slit and fill it, having its inner face formed to the same circle as the hole, and provided with two wings or flanges, one extending on each side of the slit, through which two screws, *b b*, are passed into the rail, B, which fastens the bracket thereto. A collar, A, of the usual form and size is placed in the hole when the part of this bracket, D, which enters the slip is forced up by the screws, *b*, upon the collar which bears on it with a surface area equal to the depth of the rail and the width of the slit, and by reason of the extent of this surface bearing and the pressure of the screws, the collar is secured fast into its place. When adjustment is required it is obtained by slackening the screws, *b*, when the collar, A, can be moved up or down, or round in the same way as with the ordinary pricking screw, and when the required adjustment is made the bracket is screwed tight.

The slit allows of the spindles being placed in the frame by simply

Fig. 6.



passing them into their places through the slit, *a*, dropping down the collar, A, as usual over the end, and then fastening by the bracket, D. It also allows of ready removal of the spindle by taking off the bracket, D, removing the collar, A, and bringing the spindle out through the slit in front. These improvements in the mode of fitting the bushes or steps and collars of spindles of spinning frames, are equally applicable to the bushes or steps and collars of the spindles of roving, twisting, and winding frames, or other similar frames where spindles are used. Fig. 6 represents a side elevation of the "bend" of a spinning frame with the improvements attached, as embodied in the second division of

the second part of this said invention, which consists in constructing the bend, A, in such a manner as to admit of a horizontal, or nearly horizontal, shift of the retaining rollers, whilst the same shifts as heretofore employed are continued to the conductor rod and intermediate roller, or rove plates, the power for binding the rove by them being thus varied to any required degree by changing the relative positions of the drawing and retaining rollers. This shift, to be of any practical value, requires to be easily made, and the bushes or bearings of the retaining roller to be maintained always in a correctly straight line. This is accomplished by forming that part of the bend which holds the bush, B, of the retaining roller so as to allow of it sliding back or forward in two halves in a horizontal, or nearly horizontal line, say of 2½ inches in length. For each bush there are made say four filling pieces, *a a*, of iron or other hard material, of the respective thickness of 1 inch, ¾ inch, ½ inch, and ¼ inch, but of uniform length and width. These filling pieces are caused to fit easily into that part of the bend which holds the bush, and which, when the whole are placed either on one side or the other of the bush, fill the slide, as shown in fig. 6, where two filling pieces or bits of different thickness are introduced into the slide on each side of the bush, B. After insertion they are screwed fast into the bend by means of a cover, C, and two screws, D D. When all these four filling pieces are placed at the back of the bush, it is evident that the retaining roller will be 2½ inches farther forward than it would be if they were all placed at the front, and the whole screwed up in the same way. It is by slackening the screws, D, without taking out the roller or bush, and taking out one or more of these filling pieces, *a*, from one side of the bush, and placing it or them on the other side and tightening them up again by the screws, D, that a shift of the retaining roller is obtained, and the whole shift of 2½ inches in portions of a quarter of an inch, or multiples of a quarter of an inch, at a time can be made; this division of a quarter of an inch is sufficiently small for practical purposes, but any other division can be obtained according to the thickness of the filling pieces employed, or any total length of shaft can be obtained by increasing or diminishing the length of the slide seat for the bush in the bend. These filling pieces are made, unlike the bush itself, without flanges, so as to admit of their being removed without removing the bush or roller, the pressure of the cover and screws being sufficient to hold them in position; but as security against any movement to one side, they can be kept in position by having a projecting steady pin fastened into each, the projecting part of the pins fitting into holes made to receive them in the bend and cover, and into corresponding holes made in each piece or "bit." The grates that hold the pressing and retaining rollers, and the levers that press them on to the front retaining roller, must be arranged so as to follow and admit of the shifts being thus made on the front retaining roller.

MANUFACTURE OF PAPER.

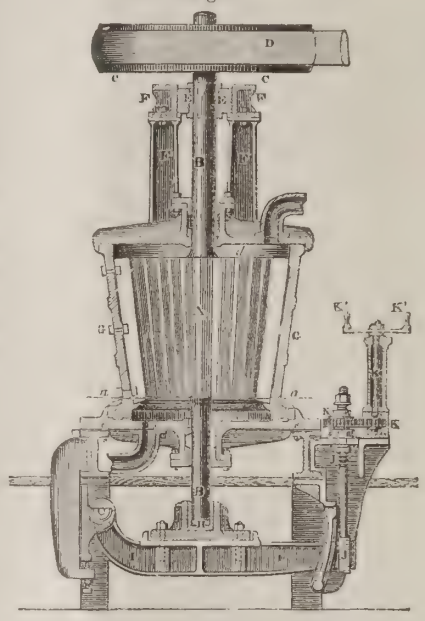
GEORGE BERTRAM, *Edinburgh.—Patent dated 15th December*, 1866.

MR. BERTRAM'S invention has for its essential object the construction and arrangement of certain apparatus or means to be used for the conversion of half stuff into the pulp from which paper is manufactured; the apparatus or means being intended as a substitute for and to supplant the ordinary beating engine, or other means for beating pulp at present in use.

The apparatus consists of a hollow case of a truncated conic form, situated by preference in an inverted vertical position; its upper and lower ends are closed with suitable metallic covers; the bottom cover also constituting the sole plate upon which the pulp-beating mechanism rests. The interior of the case is fitted or provided with a series or set of knives, cutters, or disintegrators; and in the interior of this truncated conic case a correspondingly shaped grinder is caused to revolve by any of the well-known and ordinarily employed mechanism for imparting rotation. This revolving conic grinder is also provided with cutters or disintegrators all around its circumference, and the half stuff is ground or reduced by continual trituration between the grinding edges of the revolving grinder and those of the case. The spindle or shaft upon which the grinder is carried passes through stuffing-box bearings at the centre of the upper and lower covers of the grinder case, and the lower end of the spindle or shaft is carried by a footstep bearing, fitted on an adjustable lever, by raising or lowering which the distance between the disintegrating edges of the grinder and its case is adjusted, and the degree of fineness to which the pulp is reduced correspondingly regulated. The conic case is provided at its upper end with a duct, through which the half stuff is led in. Another duct is also provided at the lower end through which the pulp is educed as it is ground.

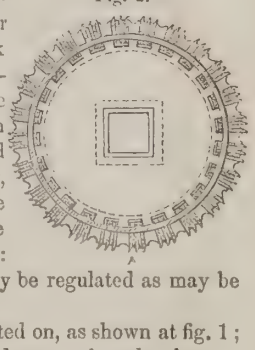
Fig. 1 of the engravings is a vertical section of the case and some of the details of the improved engine for grinding pulp, showing the grinding cone, shaft, and belt pulley in elevation; fig. 2, a top plan of the grinding cone; fig. 3 is a part horizontal section and plan on the line *a a*, fig. 1; and fig. 4 is a half horizontal section on the line *b b*, fig. 2, and a half plan of the top or cover of the grinding case. In all the figures where it is shown the grinding cone is marked A. It is carried upon the vertical shaft, B; a portion of the shaft being made square, as shown at fig. 2, to enable the grinding cone being very firmly fixed thereon. At the upper end of the shaft, B, the driving pulley, C, is keyed, over which the belt, D, passes, and by which rotation is imparted to the grinding cone.

Fig. 1.



The upper end of the driving shaft, B, is carried in a guide bearing, E, which is very securely held to and by the framework F, fig. 1; or, if convenient, the bearing may be secured to a girder or bearer of the building in which the pulp engine is placed. This bearing, E, is fitted with adjustable screws or bolts, so that it may at any time be set fair with the central line of the conical grinding case, G. The upper and lower parts of the shaft, B, where they pass through the covers of the conical grinding case, G, are surrounded by stuffing boxes as shown at fig. 1, so that the joints at these parts may be made quite secure against leakage; and the lower end of the shaft B, is carried in a footstep bearing, H, situated on the lever, I. The footstep bearing is provided with two plates, *a* and *c*, one of which may revolve, so that the friction which would otherwise occur is diminished. The lever, I, being made adjustable in a vertical position, either upwards or downwards, by means of the adjustable link and screw, J, and the gearing, K, for actuating it; the distance between the edges of the knives or the grinding cone, A, and those on the interior of the case, G, may be regulated at will, by simply raising or lowering the lever, by turning in a right or left hand direction the handles, K, causing the grinding cone, A, to be elevated or depressed within the grinding case: thus the coarseness or fineness of the pulp may be regulated as may be required.

Fig. 2.

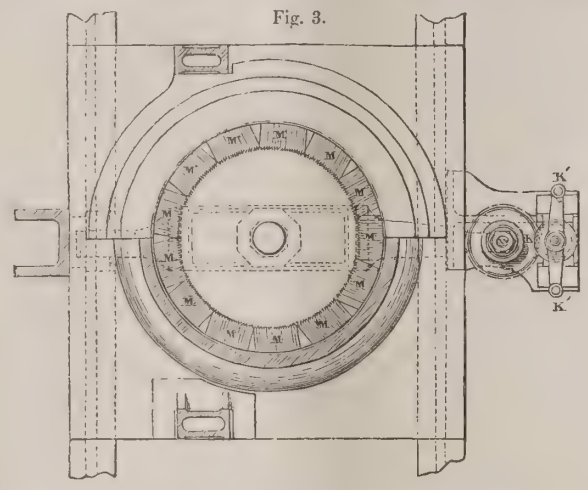


The top cover of the grinding case, G, is bolted on, as shown at fig. 1; and the lower end is closed by its being bolted down to the sole plate, L, as also shown in the same figure, this being carried upon girders, L', or otherwise carried as under any circumstances may be desired. The knives, disintegrators, or cutters, as they may be variously termed, are marked M, both in the casing, G, as well as the cone A; and they are made up in sets or blocks of several plates of steel of an eighth of an inch thick or thereabouts, any number of which may be fastened together by screws, bolts, or rivets, substituting what in the common pulp-beating engine is called "the slabs," when blocks of steel plates extend through the greater part of the depth of the interior of the cone, as shown at fig. 1; and they are set to coincide with the taper of the cone, or at an inclination to the axis of the cone, so as to form a shear cut with the disintegrating or cutting plates on the cone itself. The sets of bars are at a greater distance apart at the top than at the bottom.

The inside of the case is of a much wider diameter than the revolving cone is, both at the top and bottom, to allow of the blocks of steel plates to be admitted, as seen on plan, figs. 3 and 4; and the plates being fitted up in sections, are fastened to the case by means of screws and bolts passing through the sides of the case, which are easily removed when wanted.

The bars in the cone and "plates" are sharpened to a thin edge, as is usual with pulp-beating engines, and made perfectly true, so that the bars in the cone, as it revolves, shall come in contact with all the bars in the "plates," with the exception of a short distance down from the top of the cone, where the steel bars are intended to be slightly clear of each other for the admission of the pulp. The cone itself is by preference formed of cast iron, the spindle, B, being fastened into it as hereinbefore-described, after which it is turned to the necessary

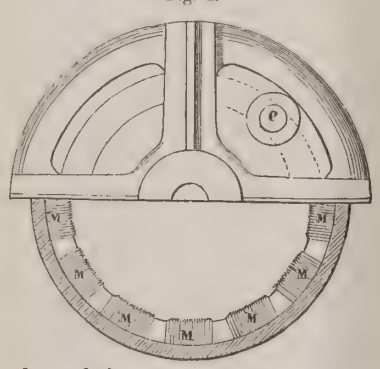
Fig. 3.



finished shape and size in a lathe. In casting the cone, there are grooves formed in it which extend from the top to the bottom, and into which the sets of steel bars, cutters, disintegrators, or knives are fitted, as shown at fig. 2; three such cutters, disintegrators, or knives, being combined together in each set, after which, being keyed in place, they are firmly bound to the cone by the malleable iron hoops, *d d*, one at each end being shrunk into a recess formed to receive it.

The operation of grinding or "beating the stuff" is as follows:—The half stuff, after being washed, sized, or coloured in the ordinary washing engine, is passed through the conic grinding surfaces, entering by the top cover of the casing, through the supply pipe, *e*, of considerable elevation, so as to cause a pressure on the pulp, and force it into the bars of the cone as it revolves. The stuff thus taken in by the cone at the top side gradually passes down, when it comes in contact with the finer set bars, both in the cone and "plates," so that, as it escapes from the lower end of the cone, the pulp is in a fit state to make the kind of paper intended. For regulating the supply into and discharge from the cone, valves or taps of suitable form and dimensions are provided, so that the requisite quantity can be admitted, kept a proper time within, and discharged in a continuous stream, ready to be made into paper. The proper degree of pressure to be given to the cone while it revolves in contact with the steel plates, can easily be given by turning the handle, K, so as to lower or elevate the cone; and when the proper degree of fineness for the pulp is once arrived at, the nut, Z, seen on fig. 1 on the top of the regulating screw, is brought down to bear on the top of the nut in the wheel, so as to prevent the cone coming nearer to the grinding surfaces; after which the nut, Z, is secured and locked in its place by a "master-key," so that the work may go on uniformly.

Fig. 4.



LAW REPORTS.

M'Dougall *v.* Girdwood.—Sheep-dipping Composition.—Before the First Division of the Court of Session in Scotland.—June 18, 1867.—This was a motion for a new trial of certain issues which had been directed in an action brought by the plaintiff against the defender in respect of the alleged infringement by the defender of the plaintiff's letters patent dated October 15, 1860, and granted to the plaintiff for an invention of "Improvements in materials or compositions for destroying vermin on sheep and other animals, and for protecting them therefrom." The issues, which related to the infringement only, were tried before the Lord President in April last; and the trial, which lasted three days, resulted in a verdict for the plaintiff. The trial is reported *ante*, p. 55.

The defendant now moved for a new trial—1st, On the ground that the verdict was contrary to the weight of the evidence; 2nd, On the ground that the Lord President's charge to the jury was wrong in the following particulars, viz., that the Lord President left it to the jury to say, on the evidence, whether the words in the specification, "the heavy oil of tar, or dead oil, or crude carbolic acid, as it is sometimes called, or creosote obtained in the destructive distillation of carbonaceous substances," do in their ordinary meaning, as known in trade, comprehend oils produced from the destructive distillation of coal-tar of a specific gravity less than the specific gravity of water, and particularly the oil used by the defender in the manufacture of the composition complained of as a contravention of the patent, and he directed them in law, that they must find a verdict for the defender if they should be of opinion that the said words do not comprehend such oils—and further, that the Lord President ought to have directed the jury, in point of law, that according to the true construction of the letters patent, specification, and disclaimer, no oil of a less specific gravity than water is comprehended within the said patent, specification, and disclaimer; and that if the coal-tar used by the defender was, prior to the date of the patent, commercially known and used, and was of a lighter specific gravity than water, the pursuer is not entitled to a verdict on either issue.

Mr. Watson and Mr. Vasy Campbell, instructed by Mr. Andrew Webster, S.S.C., were counsel for the defender.

Mr. George Young, Mr. Mackenzie, and Mr. Balfour, instructed by Messrs. Macnaughton & Finlay, W.S., were counsel for the plaintiff or pursuer.

The case was heard on the 18th, 19th, 20th, and the 21st June, and on 25th June the Court delivered the following judgments, from which the line of argument raised by the counsel for the plaintiff and defender sufficiently appears:—

Lord Curriehill, after stating the case, said, that as to the first exception to the Lord President's charge to the jury, it appeared to him that the judge could do nothing else with propriety but leave it to the jury to say what was meant by the words of the patent. The article is described by the words, "the heavy oil of tar, or dead oil, or crude carbolic acid, as it is sometimes called, or creosote obtained in the destructive distillation of carbonaceous substances." Now, there was a duty incumbent on the judge, and that was to direct the jury that they must give a verdict for the defender, if they should be of opinion that the words of the patent did not comprehend such oils; accordingly, his lordship did give such a direction. But the exception is, that he should have gone further, and told the jury whether or not these words, in their ordinary meaning as known in trade, comprehend oils of a certain specific gravity. How is the judge to instruct the jury to that effect? It implies that he must know distinctly the meaning of the words, "the heavy oil of tar," and so forth, as quoted in the issue. How was the judge to know that? These are not words of a technical meaning in the law of Scotland. They are words indicating a certain mercantile commodity; and the meaning of these words is to be ascertained from people who are acquainted with that commodity; and therefore it depended upon evidence which should be led to the jury what the meaning was. But the argument appears to have been that, in the specification itself, words are to be found which enabled the judge to put a construction upon these words, and that he was bound, having to read that document, to take the information which it afforded in order to give that construction. It is said that in that clause of the specification which sets forth what is called the *modus operandi*, he finds words there which enabled him, and made it incumbent upon him, to instruct the jury that the heavy oil of tar must have been of a certain specific gravity. Now, he (Lord Curriehill) found no such words in that part of the specification which describes the invention; and with regard to the words occurring in the other part which specifies the *modus operandi*, he thought the exception proceeded upon a mistake as to the nature of the object of that part of the patent. By the Patent Law, the patentee, besides describing his invention in words that admit of no dubiety, is bound to do something more; he is bound to describe a mode in which it can be carried into practical effect, so that any third party of ordinary intelligence in such matters should be able to perform the operation with this prescription before him, and without further instruction. It is not necessary that in that clause the patentee shall describe every mode in which the operation can be carried into practical effect; it is sufficient that he describes distinctly one mode; and accordingly it will be observed that in that clause of the patent in question, he does not profess to do more. He says that "in order that my invention may be fully understood, I will proceed to describe a method by which I carry the same into practical operation;" and it is in describing that one method that he there says that he is in the habit of taking oil having a greater specific gravity and a higher boiling point than water. That simply comes to this—that for the particular method in which he says his invention may be carried into practical operation, he is in the habit of taking oil of that particular kind. But these words do not occur anywhere in those clauses of the patent which are meant to describe the patent itself. That being the case, the judge was not bound, nor even entitled, to take upon him to construe the meaning of the description of the patent, as occurring in the proper clauses of the specification, by resorting to this allusion to the gravity of the oil in the particular mode of carrying it into execution, which is stated here. The first exception was not well founded; and the same remark led to a solution of the next exception. The patent specification, and the disclaimer, read all together, say nothing about the specific gravity of the oil at all; that is not one of the elements of the patent. Then, with regard to the second branch of the second exception, it

is, "that if the tar-oil used by the defender was, prior to the date of the patent, commercially known and used, and was of a lighter specific gravity than water, the pursuer is not entitled to a verdict on either issue." He thought that this was not a direction in point of law at all. It related not to any abstract proposition, but to the tar-oil used by the defender being of a limited kind. That takes it out of the category of being a proposition in law, and therefore the judge was acting properly when he refused to give such a direction. That being the case, it only remained to consider the question as to the rule. Now, the same remarks lead to this, that it was a proper jury question whether or not these words, in their ordinary meaning, comprehended the use of oil of a gravity less than the specific gravity of water. Upon that question we must look to the evidence, and there is certainly great contrariety of testimony on the subject. Persons of skill and persons of experience gave a great deal of evidence; and it was brought to be very clearly a case for the jury, and the jury have accordingly disposed of it by giving a verdict in favour of the pursuer. This was not a case for a new trial. One can imagine very considerable doubts raised as to whether or not this clause, which specifies the *modus operandi*, is really specific enough to serve the purpose for which such a clause was introduced; but that question is not here. If it is ineffective in that respect, that may be a good objection to the validity of the patent; but there is no objection stated in this action to the validity, and his lordship thought that this verdict should stand, that the exceptions should not be admitted, and that motion for a new trial should be refused.

Lord Deas was of the same opinion, with this explanation, that even supposing the description of the *modus operandi* may be taken into view in construing the meaning of the words in the descriptive part of the patent, he should still arrive at the same result; because he thought that even upon that assumption it was necessary to have evidence before the patent could correctly be construed; and if it was necessary to have evidence to construe it, he thought it follows that it was no longer a question of law, but a question for the jury, as to what right or rights the pursuer might have. As to the rule, he thought it was a fair jury question; and he saw no reason to doubt that it was deliberately and fairly considered by the jury, and he was not prepared to say that they arrived at a wrong conclusion.

Lord Ardmillan was of the same opinion. There had been a good deal of subtlety in the manner of dealing with these two exceptions; because it is quite true that it is for the judge in the general sense to construe the specification, but in doing so it is necessary in some cases of construction of a written document, that the judge is aided by the evidence—evidence explanatory of terms used in business and other such matters; and that here the true, fair, *bona fide* meaning of the words of this patent, looking to the objects in view and the nature of the elements used in the composition of this mixture, was a fair matter for the judge to be instructed by the jury—the jury taking evidence of what was the meaning of the words. In other words, the judge takes the aid of the jury on the evidence to read the specification; and having read it by the light which was obtained in that manner, then he construes it. Therefore there is both the jury question and the legal question, and the legal question arises after—through the medium of the evidence laid before the jury—the judge has ascertained the meaning of the words. Accordingly, it was put for the defender that the legal point might arise in this position, that if the jury came to be of opinion that light oil—oil lighter in specific gravity than water—is in the ordinary meaning of the term within the patent, still the law might read the patent otherwise, and hold the light oil not to be within it. Now, that is an aspect of the case in which a strong question of law was submitted, and he quite concurred in the direction of the judge on that question of law. That is the only aspect of the case in which the question of law which the defender attempted to raise would rise to the jury. The other question was a proper jury question. It is a question of some nicety, but the jury were entitled to consider, and have considered it; and although he could not say that it was free from doubt, he concurred in holding that the verdict of the jury should be maintained. Therefore his lordship for refusing the exceptions, and also for discharging the rule.

The Lord President said, There are two very important rules applicable to the construction of specifications of inventions. The first is exclusively applicable to the construction of such instruments, the other is one that is equally applicable to almost all written instruments that are made the subject of construction in a court of justice. The first of these is, that while everything bearing upon the nature and extent of the claim of the patentee as disclosed upon the specification is for the construction of the court, the compliance of the patentee with that condition of the letters patent which requires him to disclose the manner of using his invention, in such a way as to enable persons of ordinary intelligence to use it, is for the jury; and accordingly, as regards that latter portion of the construction of the patent, when an objection is taken to the disclosure of the manner of using the patent, it always is put in a separate issue for the defender and sent to the jury as a proper question for them to determine. But then the second rule applicable to the construction of a specification is this, that while, in the ultimate result, the construction must lie with the court, there are often facts to be ascertained by evidence to enable the court to exercise its proper functions in construing the instrument—as in the present case, it was absolutely necessary to ascertain the meaning of certain terms which the patentee had used; because these were not either legal terms, or terms of ordinary language, but were terms used in a particular department of trade to express certain commodities or products of that trade with which no judge can be supposed to be familiar. Now, in that state of the matter, the question arises whether the defenders were well founded in asking the presiding judge to construe the patent, irrespective of the meaning of those words, or whether they were right in saying that, at all events, the meaning of those words was not a question to be left to the jury. That may mean one of two things. The defender's contention may either mean that the judge was to construe the patent according to the words used in the specification without any reference to the evidence, and without deriving any aid from the evidence at all. It appears to me that that is quite an unsound contention, because there were undoubtedly words contained in this specification, the meaning of which was indispensable to be ascertained in order to know what the patentee meant, and which the court had no means of ascertaining except by evidence. But then the defender's contention may, in the second place, mean that the judge should have taken that evidence into his own hand, and have said, upon that evidence, what was the meaning of the patent. That, again, appears to me to be very unsound, because I think that would have been the court usurping the function of the jury. But then, in the third alternative, if the jury are to construe the words according to the evidence which has been led, then is the judge to say that, notwithstanding of the construction that they may put upon the words used in this patent, there is nevertheless, within the patent itself, sufficient to control the meaning of these words, in such a way as to lead to the result that the words which the jury have found, in their ordinary signification, to include what is called the lighter oil, yet cannot be read in this particular instrument as including the lighter oil? That seems to be the only remaining question. Now, it appeared to me at the trial, and everything I have heard since confirms me in that impression, that if I had taken that course I should have acted unjustly to the claim of the patentee, and I think I should also have violated a very plain and obvious rule in the construction of such an instrument, because the words which were to be construed by the jury according to the evidence, were words used in describing the nature and extent of the patentee's claims, and these words were "the heavy oil of tar, or dead oil, or crude carbolic acid, as it is sometimes called, or creosote, obtained in the destructive distillation of carbonaceous substances." The jury came to be of opinion upon the evidence that these words were sufficient to include the oil used by the defender in his manufacture. If I was to proceed to construe the patent so as to arrive at the conclusion that these words did not comprehend the oil used by the defender in the preparation of his composition, I should just like to understand by what form of reasoning I was to reach that. But then the argument is, that the portion of the patent which followed is so expressed as clearly to import that the patentee did not mean, when he was framing this specification, that the words to which the jury have given this large meaning, should give that large meaning to his patent. Here, I think, there is a very gross fallacy arising from failing to separate the two parts of the specification, and to assign to each of them its proper office. The paragraph which begins with these words, "And in order that my invention may be fully understood, I will proceed to describe a method by which I carry the same into practical operation," may be said to be the part of the specification that is addressed to the public. It has nothing to do with the defining of the patentee's claim; and the words which are used in that part of the specification are used for the purpose of elucidation—of making perfectly plain and intelligible to the intellect of ordinary working men how the patentee, or any one into whose hands this specification comes, may make the composition which the patentee has invented. If he had used in this part of his patent words totally and entirely different from those used in the definition of his claim, it would not in the least degree have affected his patent; because if this part of the patent makes it intelligible to persons of ordinary skill how they may make the patent composition, that is all that it is intended to do, and it cannot with justice be allowed to have any other effect. It was also argued, however, that there is another portion of this specification which shows that what was in the mind of the patentee was entirely oils of a greater specific gravity and higher boiling point than water, and that is the concluding paragraph, where he states again, as is usual in a specification, what it is that he claims as secured to him by his letters patent. Now, what he claims as secured to him by his letters patent is this—"The use of alkalies and tallow or other saponifiable substances in combination with the above products when used for the purposes above set forth." The "above products," it is said, must have reference not only to the paragraph in which the invention is defined, but also to the paragraph in which he instructs the public how they may use it. I think that is entirely fallacious. I think the reference back, in stating the claim at the end, is to the statement of the claim in the earlier part of the patent, and not to that other part of the specification which is addressed to the public, and has nothing to do with the stating and defining of the claim at all. So that even if I could have got rid of the difficulty of finding it established by evidence that the words in this part of the specification are not so extended as to include the oil used by the defender in his manufacture, I should still have thought that the principle of construction which was urged upon me by the defender was, in patent law, a bad principle of construction, and one inapplicable to this or to any other patent. I do not mean at all to say that, in construing doubtful words or phrases in the specification, the words or phrases which occur in that part of it that states the claim may not receive some elucidation from words or phrases used in that part of it which explains how the invention may be used, because I think that would be carrying the doctrine which I am now stating a great deal too far; but what I mean is this, that where, either in themselves or by evidence, the words in the statement of the claim have a certain ascertained meaning, you are not to overrule or control that merely by the occurrence in the other part of the patent addressed to the public of something that may appear at first sight to be not quite reconcilable with the meaning of the words in the statement of the claim. I have thought it right thus to state the grounds on which I come to the same conclusion as your lordships. With regard to the case upon the evidence, I am bound to say that I thought the case one of a somewhat doubtful kind, and I believe the learned counsel will confirm me when I say that I left that entirely to the jury, without even indicating to them in the slightest degree which way my own verdict would be. I think it was a fair and pure jury question; and having been determined by a jury one way or other, I should not be disposed to disturb their verdict.

Their lordships therefore disallowed the exceptions, and discharged the rule, and found the pursuer entitled to the expenses of the discussion.

REVIEWS OF NEW BOOKS.

THE ELEMENTS OF MOLECULAR MECHANICS. By JOSEPH BAYMA, S.I., Professor of Philosophy, Stonyhurst College. 1 vol. 8vo. Macmillan, Cambridge. 1866.

THIS really profound work is one that passes far beyond the range which authors on molecular physics, such as Larné and others, have prescribed to themselves. It aims at passing from the acknowledged

facts and laws of mechanics of a point, step by step to the building up of a tenable theory of the constitution of matter, and of the laws of the actions which hold it together or divide it, and so to become the real and mathematical basis for a future chemistry and crystallography.

The germ of the work was communicated three or four years ago to the Royal Society, in a paper on Molecular Mechanics, which the author has now expanded into his completed, and we must say, notwithstanding some difficulties and hypotheses not at once receivable, most important and suggestive work. It is far more than a mere college exercise of mathematical gladiatorship; it is a work that men of the stamp of Stokes and Rankine will receive with interest. It soars in a region, however, at present quite beyond the ken of the practical mechanic; though a future day will come when such a building as is here sketched will constitute the foundation courses of all ordinary teaching in physics, chemistry, mineralogy, and other branches of natural science.

SOUND; A course of Eight Lectures delivered at the Royal Institution of Great Britain. By JOHN TYNDALL, LL.D., F.R.S. 1 vol. 8vo. Illustrated. Longmans, London. 1867.

THERE is little use in our saying what Professor Tyndall does say or does not say in this capital addition to the preceding volumes with which he has enriched the scientific literature of England. We simply say to all our readers, go and get the book and read it. Those who had the good fortune to hear any of the lectures will be pleased to recall the vivid impress then received by the lecturer's admirable and lucid exposition, enforced by his always ably-conducted and appositely-imagined experimental illustrations, of the chief phenomena and laws of sound, including those singular facts as to sounding flames, which he was so prominently instrumental in elucidating, though not claiming to be their original discoverer. Those who are already well up to their physics in their acoustical branch will be glad to have their memories brushed up, in the pleasant and striking way of which Tyndall is a master; and those who know nothing of the subject of Sound will here find knowledge as easily conveyed and as freed from technicality as it is possible to be, and yet preserve that rigid accuracy and generality which are so commonly lost altogether in popular works on science, but which Tyndall never for a moment loses sight of. There remains in Sound quite scope enough for eight lectures more, and another volume. We hope the author will take our hint.—ED.

THE MECHANICAL THEORY OF HEAT, WITH ITS APPLICATIONS TO THE STEAM ENGINE AND TO THE PHYSICAL PROPERTIES OF BODIES. By R. CLAUSIUS, University of Zurich, &c. Edited by Professor A. HIRST, of University College, London; with Introduction by Professor TYNDALL. 1 vol. 8vo. Van Voorst, London. 1867.

THIS is a welcome addition to English scientific literature, coming from the hand of a competent mathematician as translator, and put by the author and translator together into a form likely to be of use to very many to whom the original German memoirs would have been useless; for the real difficulties of Clausius' mathematics did not need those of a difficult foreign tongue to make their subject forbidding to all but a very few in England. As the memoirs on Heat, or some of them, left the hand of the author originally, his mathematics were in some respects of a character capable of misconception even by German mathematical readers; and his use of certain differential equations not directly integrable, after the method pointed out by Monge, was of such a nature as to have induced doubts of his conclusions in the minds of some, who attacked in *Dingler's Polytechnic Journal* parts of some memoirs which appeared in *Poggendorf's Annalen*. The author prevents the recurrence of this hereafter by a lucid preliminary chapter, in which he explains his method and use in respect to these equations. This is followed by his first nine memoirs, of which in general it may be said that though all are full of import and value, the first is by far the most important. The introduction by Professor Tyndall is confined to a modest page from him, in which he acknowledges his own obligations to Clausius, and merely states that seventeen years ago he himself was the translator of Clausius' first memoir for the *Philosophical Magazine*. Neither Clausius' nor Hirst's names surely needed the justly-respected but here unnecessary name of Dr. Tyndall to usher the work of the former before the English public. This work, we think, notwithstanding that the character of its investigations and the mathematical language in which these are couched are above the usual range of mechanical engineers in Great Britain, must prove of service in further diffusing an exact knowledge of the modern views as to heat and motion. Its very appearance makes us the more desire that Professor Tyndall himself, whose work on Sound has just appeared, would return to his desk, and in fulfilment of the well-expressed desire of another distinguished labourer in the field of the mathematics of heat, Professor Rankine, would apply his unrivalled accuracy and felicity of popular illustration to the second law of thermodynamics, and make it as clear to the brain not versed in the higher mathematics as he did the first law, in his work "Heat considered as a Mode of Motion." Almost at the same time that this translation of Clausius' first nine memoirs has appeared in London, Clausius himself has published at Braunschweig the second part of his "Abhandlung über die Mechanische Wärmtheorie," in which he profoundly treats, in nine new memoirs, of the relations of heat to electricity, light, and the molecular constitution and changes of bodies. The seventeenth memoir comprises some extremely curious speculations on the nature of ozone, as indeed does also the following and last memoir.

INJURIES OF THE EYE, ORBIT, AND EYELIDS; THEIR IMMEDIATE AND REMOTE EFFECTS. By GEORGE LAWSON, F.R.C.S., England, &c. 1 vol. 8vo. Longmans. 1867.

OF the merits of this work in its purely physiological and pathological aspects we are scarcely competent or called upon to judge. Surgery, however, as its very name (in its etymology χειρ εργον, "work by the hand") indicates, has its direct relations to the mechanician, and we can admire and appreciate the dexterity and skill with which the instrumental and operative methods are described for the relief of injuries to the eye, the most precious organ of the body, and recognize the logical sequence with which the entire subject is treated throughout the volume. The chapter on foreign bodies within the eye has besides its interest to all, for all are liable to dust and grit, &c., is of special interest to the working mechanic, who often gets sharp fragments into his eyes, which, if not soon and completely removed, may end in loss of sight. Like many other first-class professional works, this is one which even an idle man may peruse with interest. Amongst the cases recorded of injury to the eye, for example, is one of a drunken man who fell down stairs and buried 3½ inches of a cast-iron hat-peg in the orbit of his eye, breaking it off short from its fixings, and yet who recovered. There are a large number of admirably executed illustrations of affections of the eye, and of instruments employed by the oculist, and a full set of what are called Jaeger's test types of vision.

FOREIGN LITERATURE.

HANDBUCH DES MAGNETISMUS. Bearbeitet von Dr. J. LAMONT, Prof. an der Universität und Conservator der K. Sternwarte in Munchen. 1 vol. 8vo., with illustrations. Voss, Leipzig. 1867.

THIS full and careful, if not exhaustive, treatise on magnetism by Professor Lamont, of Munich, which has just appeared, forms the fifteenth volume of the "Allgemeine Encyclopädie der Physic," of which Gustav Karsten is editor in chief, and which when completed will comprise probably the most complete and copious library of pure physics now in existence. The present volume has no less than 281 woodcut illustrations inserted in the text.

In fifteen elaborate chapters the whole subject of natural and artificial magnetism is developed in a manner strict throughout, and by the proper aids of symbols and formulæ, but always having regard to the experimental and technical aspects of the immediate subject also. In the third chapter an able *resumé* will be found of the mathematical theories of magnetism of Biot and of Poisson, and what may be called a new theory, based upon certain hypotheses of molecular induction, is discussed. The volume, which is of too learned and recondite a character for our readers, except such as are professionally engaged in electric or electro-telegraphic works, with which pure magnetism is so intimately concerned, concludes with a copious bibliography of its subject, and with what is but too rare latterly in German books of science, an excellent index.

CORRESPONDENCE.

☞ We do not hold ourselves responsible for the views or statements of Correspondents.

(*To the Editor of the Practical Mechanic's Journal.*)

Sir,—I have an 8-horse double-cylinder portable engine which I desire to use to irrigate some land with. I require to raise as much water 6 feet high in a short time as is possible with, say, 40 to 50 lbs. pressure. I have been told there are some very effective cheap plans in use in the Fens, and want information about them. Please advise me in next month's Journal, if you can.

Yours, &c.,

J. LANCASTER.

73 Stevenson Street, Canning Town, Barking Road, E.,
22*nd May*, 1867.

[We should suppose that a centrifugal pump would best answer our correspondent's purpose, by which he might raise the irrigating fluid to a tank, from which it might be easily distributed over his lands. His inquiry, however, is very vaguely put; and if he wants more precise particulars, he had better state his wants more fully, when either we, or perhaps some of our correspondents, may give him a satisfactory reply. We are not aware of any particular means employed in the the Fens than elsewhere.—V. D.]

THE RICHARDSON PROCESS.

(*To the Editor of the Practical Mechanic's Journal.*)

Sir,—I have read with much interest the article on Richardson's process of puddling, and I think there is a good deal in it. The object I have in view in writing you is to correct an error in the figures you have given, viz.: You give the average of the yield as 3 cwts. 3 qrs. 27·25 lbs., whereas it should be 28 lbs. less, or 3 cwts. 2 qrs. 27·25 lbs., which would give 21 cwts. 1 qr. 17 lbs. pig to the ton of puddled, instead of 20 cwts. 6 lbs. pig, as 3 cwts. 3 qrs. 27·25 would make it. This is an important difference.

I am, yours truly,

JOHN HEWETT.

John Brown & Co.,
Atlas Steel, Spring, and Iron Works, Sheffield,
1*st August*, 1867.

[The error which our correspondent notes was detected by us, but not until after the pages were stereotyped, when, in the hurry of passing the pages through the press, there was not time for correction.—V. D.]

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

AERONAUTICAL SOCIETY OF GREAT BRITAIN.

A general meeting of members, under the presidency of the Duke of Argyll, took place on the 15th July, at the Lecture Hall of the Society of Arts, for the reading and discussion of papers upon Aerial Navigation and the Principles of Flight.

The French aerial screw, brought from Paris by Mr. Butler, as promised at the last meeting, was now exhibited. Mr. Bright claimed it as his own invention, but it failed to elicit any remarks in its favour as an elevating and sustaining power, except from Mr. Bright.

The following communication from F. D. Artingstall, of Manchester, addressed to Mr. Frederick W. Brearey, the honorary secretary, was read by him to the meeting.

(It may be remembered that the author's interesting experiments were described, under the initials of F. D. A., in the published transactions of the society):—

"Since I last wrote to you, I have been thinking over the experiment I made with an engine and wings attached to the end of a movable steam-pipe (as mentioned in my first letter to you). At the time when this experiment was made I did not attach so much importance to it as you might think it deserved, for this reason, that I supposed the power used to produce the effect of flight was tremendous compared with the small weight raised, and therefore in this respect no better than the aerial screw, for this would also fly beautifully at the end of a movable steam pipe, yet, in my opinion, it is not a true flight. On more mature consideration of what I will call the "pipe experiment," I suspect I condemned it too hastily, and that it contained the elements of true flight, though not well developed. The steam was suddenly let upon the piston through wide ports by the valve flying suddenly open, therefore causing the wings to strike the air somewhat like a hammer, or the motion in cracking a whip. This is what I call the percussive action of the wing. The effect of such a stroke upon the air did not give an opportunity for "slip," and the buoyant power remained longer than the impact of the stroke. The affair may be said to have been an aerial steam hammer, of which the air was the anvil and the wings the hammer. Perhaps on this plan buoyancy could be maintained by very short strokes, and consequently with but little expenditure of power. I am no draughtsman, but I will endeavour before long to send you diagrams of the "pipe experiment," as it will no doubt be interesting to the Aeronautical Society, and perhaps instructive; for I begin to think it involves a vital principle.

Dr. W. Smyth, L.R.C.P., Edinburgh, next read a paper entitled, "Experiments practically demonstrating the laws by which Birds fly, and their application to an Aerial Machine."

Although it may be impossible to discover by experiments the actual power expended by birds during flight, yet if we can determine with a good degree of accuracy the greatest amount of power the muscles by which a bird is enabled to fly are capable of exerting, we must have an approximate idea of the power required to raise the bird perpendicularly from the earth, during which the muscles employed in flying are put to their greatest strain.

Strong-flying birds, as the pigeon, are able to raise themselves perpendicularly in still air, or fly at a velocity exceeding most birds, under which circumstances they exert their greatest power. During the flight of birds in a direct line, the resistance of the air is perpendicular to the surface of their wings; therefore neither of the pressures from either wing impels the bird in a straight line, but it moves in their resultant, and at a great waste of power.

A strong-flying pigeon, weighing 12 oz., with an extent of wing surface of 70 inches, was fixed in such a way as to permit the face use of its wings; an arrangement was attached to both wings at a known distance from the insertion of the pectoral muscles, and to this a dynamometer, the wings being placed in the natural extended position; a current of electricity was transmitted along the line of the nerves leading to the pectoral muscles; the wings were instantly and strongly flexed on the body, or, in other words, struck downwards as in the act of flying, which the strain on the dynamometer showed the power exerted by the muscles was capable of raising 120 lbs. one foot high in a minute.

Now it is to be remembered that if a falling body be taken as the standard by which to estimate the power necessary to raise the figure perpendicularly, it would require to use a power equivalent to 990 lbs., which the pigeon certainly does not possess.

This was not from one experiment, as the paper would seem to read. The strain on the dynamometer was taken at different points in the arc through which the wing moves in its stroke, and the sum of all the efforts reduced to the mean for one, gives the above sum.

The weight of the muscles by which this weight was raised, was 986 grains, or about 2 ounces. The weight of a steam-engine to accomplish the same would be about 1½ lb. An electro-magnetic engine of any considerable power would weigh perhaps more than that of steam, while the weight of a non-metallic engine hereafter to be described would be about 1¼ ounce.

The weight of the entire mechanism of the bird employed in flying was 4½ ounces, thus leaving 6½ ounces comprehended in the remainder.

It has been said that the mere perpendicular impulse of a plane is utterly inadequate in supporting a weight in air, and the use of artificial wings has been repudiated by some. This is strictly true in regard to most aerial machines that have been constructed, and though we had a power equal to ten horses for every pound in weight, it must remain so for all others as long as the conditions necessary to render them effective are not attended to.

The function of flight in birds is accomplished by means of an elaborate mechanical arrangement, delicately guided by nervous sensation, as the following experiments will show:—

The wings of a pigeon, dried in the extended position, can be attached to a spring capable of putting them in motion (for a very short space of time, as it must necessarily be very light). And though this motion may resemble very much a pigeon's wings in the natural state, it will generally be found that they will be unable to raise any weight whatever. Perhaps, in a series of experiments, all at once they would seem to have caught the secret, and astonish the experimenter; generally, however, it would be only once. Now what is the virtue by which the pigeon is able to sustain such a weight, when the wings are attached to itself, and without which they can sustain nothing when attached to our machine? If we take the wing of a bird, dried in the extended state, in the hand and strike it against the air, by attending the sensations communicated to our hand, we will feel that, during the stroke, and shortly after its commencement, the wing will experience considerable resistance from the air; in proportion as we pass this point will the resistance diminish; and when the wing is suddenly stopped, if the stroke has been a long one, we will experience pressure in the opposite direction from the column of air put in motion by the wing tending to impel it downwards; the further resistance during the extreme stroke added to this would render it utterly useless as a supporting machine. To derive effect, therefore, from the motion of a plane against the air, it is necessary that we should be able to arrest it directly we experience the maximum of resistance, which will be when the motion of the plane has overcome the inertia of the air, as compared with its velocity. There is a beautiful provision for this in the wing of a bird, as another experiment will show. The nerves of sensation in the wings of a bird convey to the nervous centres an impression when their wings have attained their maximum of effect on the air, and this by reflex action through other nerves cause the muscles to arrest the wings, and bring them back for another effort.

It follows that if nervous sensation preside over the act of flying as above mentioned, if we impair that function flight must become imperfect. It is difficult in a small animal like the pigeon to isolate the nerves of sensation from those of motion. However, there are some small branches, principally concerned in sensation, which can be divided, and *their division renders flight almost impossible.* The motion of the wings is in no way impaired, the bird beats the air more violently than before, and sometimes as if by chance it hits the proper measure and rises for a moment awkwardly, but the next strokes are unguarded and bring it to the ground. It has become, in fact, an aerial machine. It is important here to notice that the wings of the pigeon are all this time putting an enormous quantity of air in motion, which is the case also with the wings attached to the spring, and is not so with the pigeon before the nerves are divided, even though it is fixed to prevent its rising.

Next, by irritating the ends of the sentient nerves connected with the trunk, we excite muscular action in the extensors of the wings.

Beyond a doubt, could we divide every sentient nerve in the wing of a bird, flying would be impossible with all its perfection of mechanism and power unimpaired.

How much truth then is in the saying that a bird's wings seems to "feel the air," which they actually do!—an expression used by Mr. Artingstall in a paper read before the society.

In birds where the shape of the wing approaches to that of a plane, as the swallow and pigeon, there is a movement during the upward stroke, which permits the

return of the wing with less resistance than if it were raised in a perfectly extended state, while in birds where the wings are much curved, as the heron and gull, no such movement exists, because the contour of the upper surface of the wing allows of its being withdrawn with the least possible resistance. The upward stroke of the wing differs from the downward in coming more slowly to a close. Birds disturb the air but little even with their most powerful strokes; otherwise with them flight would be impossible.

The importance of the resistance of the air on the inclined angle of the wing in supporting birds during flight has been fully shown by Mr. Wenham. We cannot place nerves in the wing of an aerial machine; but we can determine by experiment for each pair of wings, according to their size, form, and power, the proper angle and arc at which they will be most effective.

This must be at a great waste of power, as the conditions vary under which we are placed; but the same is true of every piece of machinery we possess. And we cannot admire too strongly the wonderful provision Providence has placed in the wing of a bird by which it is enabled, under ever-varying conditions, to fly with the smallest possible expenditure of power.

There are three practical difficulties in the way of aerial navigation: 1st, to rise into the air; 2nd, to remain there at will; and 3rd, to get down with safety. Mr. Wenham has removed one of them; he has placed beyond a doubt that, had we an aerial machine constructed with "aeroplanes," once in air, provided we propel it at a given velocity, it must be self-sustaining, but it never would come down without being broken to pieces. There are a few elaborate plans by which it could be raised from the earth, those only possible at a very few places, but not one by which you could get down with safety.

The screw-propeller has been shown to be almost useless for the purpose of raising a weight, and therefore it is equally useless for letting down one. There remains no way but by means of wings to raise a body from the earth, and let it down again with safety. One great advantage we have over birds, we have a propeller superior to anything with which they are provided, and once in air have no occasion to use the wings, but fix them to act as "aeroplanes." Many persons when they calculate the extent of wing required for an aerial machine are confounded at their size. They say, why they would stretch from here to——. Well, even if they do stretch to any place you choose to name; put them on, there is plenty of sea-room in the ocean of air, and certainly no breakers ahead. We can construct them lighter in proportion to their size than those with which any bird is provided.

If we take a pigeon and bind its feet so as it cannot use them, after the first awkwardness of its position is over, it can rise from a stand 2 inches high by the efforts of its wings.

The following is a description of an aerial machine, the principle and design of which have received patent protection:—

It was discovered, after a number of experiments, that it was possible to explode mixed gases in elastic india-rubber cells without injury to them, provided they did not exceed a certain size, were allowed to collapse, and a lot of water admitted after each explosion. Now, if we take an arrangement like an ordinary concertina and place it in an almost collapsed position, place as many of those cells as possible inside, and fill the surrounding space with water; next, if we draw out the concertina a little, a small quantity of air will rush into the cells, and should they then be connected with a gas-holder containing hydrogen or coal gas, and the concertina drawn out a very little further, a much less quantity of gas will rush into the cells. Then suppose the mixed gases occupying the cells to be exploded by electricity, the expansion resulting from which would extend the concertina to its full length, and thus become a source of power. It is well known how every pound of force expended on water is exerted on the sides of the vessel containing it, and if some of them be immovable they become fixed points from which it acts to others, and thus renders effective all the force resulting from the expansion of the cells, which is one small advantage in the face of the many obtained through Lenoir's metallic engine. The means by which air, gas, and water are severally admitted and cut off can be efficiently performed without the use of metals. The calculated weight of a one horse-power engine of this description, allowing one-fourth more than the actual sum, would be 20 lbs., which, compared with a steam-engine of the same power equalling 400 lbs., shows a vast advantage in its application to aeronautics.

The form of the aerial machine to be, as shown in the photographs, viz., cylindrical, with hemispherical ends adapted to the contour of least resistance, at one end a screw propeller, and at each end of the body a pair of wings proportionate to the size of the machine. The power as described above, and applied to move the wings. The seats to be movable, and placed in a single row along the bottom of a machine, and arranged in such a manner so that by turning a wheel similar to that used for steering a ship, their positions may be altered at will, and the level of the machine preserved.

The entire framework of the car and wings to be composed of whalebone, over which gut has been very tightly woven. This is very important; any person who is acquainted with the manner in which it is done in the case of whips, is aware that the gut can be applied over whalebone with an enormous strain, thus diminishing its elasticity, and increasing its strength several times. In no other way can you construct wings of any great size, and have them effective; and thus made, with fine silk as a covering, they are lighter in proportion to their size than those of any bird.

The framework of the machine to be covered with silk, supported at the ends by a strong network of the same material. Suppose a machine constructed as above, to be 35 feet in length by 5 inches diameter, with a propeller driven by a one horse-power engine at one end, two pair of wings moved by two horse-power each, in all equal to five horse-power, and weighing only about 100 lbs.; 15 feet in the body of the car to be filled with coal gas, which would supply the engine for four hours, or if prepared hydrogen, developed from zinc and sulphuric acid, which would add nearly 700 lbs. to the weight of the machine. It may here be observed that the weight of zinc necessary to be burned in sulphuric acid to obtain a given power, in an engine of this nature, equals the weight of coal to be burned in atmospheric air to obtain the same power. Now, it may be remembered that in the case of an electro-magnetic engine, it has been shown, as the result of a great many experiments, that the best theoretical result from the heat equivalent to the solution of a grain of zinc in a battery is 80 lbs. raised 1 foot high, while a grain of coal in a steam-engine raises 143 lbs. 1 foot high.

A machine so constructed should raise over 10 cwt., including its own weight, from the earth, and would travel with a velocity far exceeding any bird. The supports on which it rests when on the ground are curved, so that when raised from the earth they can be turned round, and will then coincide with the body of the machine.

In experiment with the non-metallic engine, I have used cells from the capacity of a drachm to an ounce; and though the fastenings in every case have been made with elastic glue, which softens below a temperature of 100°, they have never given way.

Accustomed as we are to the steam-engine, working with all the power and accuracy which metallic resistance gives, we can scarcely think of an engine composed of light material without feeling very much akin to the ridiculous. But assuredly we must apply power without the use of metals, otherwise we may close our investigation in aerial locomotion.

There is one objection likely to be used against the non-metallic engine, viz., the want of resistance of the materials to be used in its construction. Now it has been shown by a number of experiments that a cylinder of hemp cordage, 1 inch in diameter, and glued together, can bear a strain of 92,000 lbs., while a cylinder of wrought iron of the same size can only bear a strain of about 55,000 lbs.

Mr. Wenham said the experiments recorded in the last paper form an interesting addition to our stock of knowledge on aeronautics, but I rise to make a remark concerning the proposed motive power, as upon this part of the question I have some practical data. Some years ago I constructed an engine worked by the explosive force of gas, and found that $\frac{1}{10}$ of an inch of gas mixed with $\frac{9}{10}$ of air was sufficient to propel a free piston 12 inches, and the mean vacuum obtained by the returned stroke amounted to $12\frac{1}{2}$ lbs. per square inch. The propulsion of the piston was instantaneous, and the whole force of the explosion was afterwards utilized. The heat given out was so small compared with the work done, that after running for ten hours, the temperature of the cylinder did not amount to 300°. From this I infer that the cellular chambers could be made to stand the heat of the explosion without being rapidly destroyed, and would make the lightest form of motive engine with which I am acquainted. The chief drawback would be the size of the reservoir containing the gaseous fuel, and bulk is one of the greatest drawbacks to the success of aerial navigation.

Mr. Bright disputed the conclusion of the author of the paper, concerning the screw propeller, as a means of raising or moving bodies in the air, and he again reverted to the paper he had handed to the chairman.

Mr. Wenham believed, from what he had seen of the model brought from Paris by Mr. Butler, that a machine constructed upon its principle would require a force of twelve horses to raise a weight of 100 lbs. This was sufficient to show the inapplicability of the invention, which was altogether defective in principle.

Mr. Bright asserted that Mr. Wenham's objections were groundless. It could not be disputed that he had produced to the society a model which had raised itself in the air, which completely negatived the assumed defect of principle, and he contended that what had been effected by the model could easily be applied on a large scale.

Mr. E. W. Young quite agreed with Mr. Wenham as to the total inefficiency of the model exhibited. It simply spun itself round, and churned the air, so to speak, like a child's toy. The machine, though capable of raising itself in the air by the aid of the power stored up in the spring, could not raise the source of that power, which was a man's arm, and it would be impossible to obtain the same power continuously.

Mr. Butler remarked, for the information of Dr. Smyth, that he and his brother directors of the Lenoir Gas Engine Company had found a very efficient means of producing vacua from explosions by using the vapour of petroleum, and it was of much less bulk and weight than coal gas.

The Chairman thought Dr. Smyth's paper a very able one, and that the observations he had made as to the flight of birds were very interesting and original. He (the Chairman) thought that Dr. Smyth was quite right as to the limited stroke the bird made in its upward circle through the air. It seemed to be a short rapid stroke upwards, which ceased exactly at that point at which nature taught the bird that a further stroke would not only be useless, but injurious to the rapidity of its flight. The whole extent of the arc through which the stroke might extend was rarely or never traversed by the action of the wing.

Mr. A. Stewart Harrison wished to know whether it was entirely certain that the screw propeller was useless as a means of flight: Was it as certain, for instance, as that 2 and 2 made 4?

Mr. H. C. Hurry said that it was not at all certain that the screw propeller was useless as a means of *propulsion* through the air; but he thought it was received on most hands that it was useless as a means of *support* in the air, as it was continually moving the air beneath it, and thus losing the support which an inclined plane moving horizontally would obtain. As to the motive power of Mr. Bright's machine, he thought that the observation of a preceding speaker contained the whole gist of the matter. The machine was *apparently* raised by the power of the spring, but the spring was merely a reservoir, so to speak, of the force communicated to it from the outside. The power required to lift the weight in the way proposed rendered the whole machine totally inapplicable to the purpose for which it was designed.

Major John Scott Phillips read the following paper

ON ARTIFICIAL FLIGHT.

Those who have had the pleasure of reading the admirable paper by Mr. F. H. Wenham, read some months ago before a meeting of the Aeronautical Society, and since published (page 360 of *Engineering*, April 19, 1867), will have gleaned from that paper the interesting fact that the art of flying depends upon the relative exertion of pressure and speed: while the pressing surface is economized in proportion to the weight to be carried, and the speed at which that weight is to be propelled.

Mr. Wenham has also ably discussed the resistance against a surface of a defined area passing rapidly through resisting and yet yielding media, dividing the opposition thereto into, firstly, the cohesion of the particles to be separated, which in air, he says, is inappreciable; and, secondly, their weight and inertia, which require a constant power to set them in motion.

Not to dwell any longer, however, on Mr. Wenham's very useful paper, I would just glance for a moment at the third chapter of his Grace the Duke of Argyll's work, entitled "The Reign of Law," of which chapter the heading is given—"Contrivance a necessity arising out of the reign of law; example in the machinery of flight;" and I would notice that while in a note (p. 174) his Grace says that Capt. F. W. Hutton (in the *Ibis*, July, 1864) has thoroughly seized the two mechanical principles of flight, it is evident from his own able remarks upon the flight of birds, as well as from Mr. Wenham's paper, that truly we have arrived at that stage of elucidation toward the power of artificial flight in which we are brought face to face with the question—By what mechanical means can we develop the principles which are so wonderfully combined and admirably developed in the flight of birds? This is the subject upon which I now propose to enter; but remarking that it is six years since I seriously took up the subject, I would open my views by what may be termed a recapitulatory anecdote, by way of placing my ideas in an old-established current of thought, that I may, if possible, begin at the beginning, run along the ground, rise from it, and carry my hearers with me into the realms of air.

When I was a youth years ago in India, many were the bursting gallops I enjoyed over its sunny plains; and oftentimes coming upon a number of vultures feasting on their prey, I would urge my horse to his utmost speed to see if I could possibly get a cut at one of them with a long stick before he could rise above my reach. I little thought that I was then in the way of receiving practical lessons on the art of flying. But in the year 1861, studying the question of the art of flight, and perceiving that birds did not fly because they were so light, or their bones empty or filled with light air; perceiving also that the use of gas implied cross sections of voluminous shapes which never could be forced against the air, the recollection of past scenes arose before me, brought back with vivid realizing distinctness; and this, in fact, was what I saw:—As I galloped fast down upon the vultures, singling out the nearest for attack, the bird at 80 or 100 yards' distance would commence to run, stretching out his neck, and shortly beginning to prepare his wings for flight. This he did by holding them more and more loosely out from his body, with all the feathers hanging loose and edgeways to the wind, and so running with all his power; and just as that power of running was coming to its height he gave a final leap, and instantly commenced to flap most violently with his wings. Thus he just managed to elude me always by two or three yards above my stroke, and would continue his exertions, till raised thereby some 40 feet above the ground he changed his tactics. Meantime I had restrained my horse and turned to look at him. With flattened breast and outstretched wings he let himself descend along a swooping curve, and then he would come fearless past me, every separate extreme wing feather stiff as possible, and with a rushing mighty wind he would sweep downwards till he almost touched the ground, and then his perfect power of flight was fully gained. He had obtained velocity and pressure on the atmosphere; he had heaped before him a mass of air fully equal to his own weight; and thenceforward all was easy. Gracefully and slowly waving his long wings he swept upon his way, soon leaving me miles behind him, and with long years to intervene before I could even hope to understand the principles of his magnificent development.

On the same principles the eagle, from his eyrie mid the rocks, swoops downward ere he rises to the sun; and aloft, when soaring in the heavens, scarce ever seems to move his wings at all. Steadily bearing down an exceeding long most gradual decline, he soars by the simple combination of velocity and pressure on the air; and gaining momentum from his weight upon this long descent, his upward rise is easy; for, altering merely the angle of his wings, he turns and rises, or rises without turning, by this simple manœuvre. And, as a final evidence of this fact, since all have not the privilege of visiting Libyan ranges or Himalayan hills, let me mention what may not unfrequently be seen when travelling by the railway at about the speed of 30 miles an hour, the rate apparently at which a partridge flies under ordinary circumstances. The bird, after all his whirring exertions at rising, flits steadily long distances on the wing, and coming to a hedge, just seems to change the angle of his wings and rises over it, and changing again, turns quickly down and passes out of view.

It is or will be just the same in flying by a machine, with this important difference, that, as we cannot find out the Almighty unto perfection, and make that perfect instrument, a flapping and sustaining wing, we must follow at humble distance in the use of separate instruments for gaining velocity and sustaining pressure. And, therefore, I will now attempt to show how readily this theory of flight may be applied to cause mankind to traverse through the air; premising, that I do not aim at more than running along the ground to gain an adequate pressure on the air, then at rising in the line of least resistance, then by increased rapidity of flapping to maintain the flight, and, on the whole, to pass through the air as the crow flies, direct from place to place, without turning in the flight. Suppose then that we adopt a series of planes for pressure on the air, while the person who would fly sits suspended beneath them. We then require the means of regularly, steadily, swiftly, propelling these planes against the air. First then take the planes, say one plane of the strongest and lightest wooden frame, strained with stout canvas, and let this plane be an oblong, 20 feet long by 10 feet wide. At the 10 feet ends join on by hooks, eyes, and rods two other larger planes, each as it were double planes by reason of their total area, 25 feet by 20 each, being supported by a middle bar, straining their wooden frames also with stout canvas; and let each of these two larger frames be furnished with a ratchet movement and pins, to enable the flyer, seated in a car beneath the centre or the body plane, to set them at an angle as he pleases. Secondly, place this apparatus upon light wheels, as light as possible consistent with strength, and let these wheels work on an axle (driven by a steam engine) passing across just underneath the body plane, so as that the wheels shall just work truly and freely along the sides of the body plane, and between the projections of the larger planes as affixed to the body at each end.

The planes, you will perceive, are not wings for flapping, only wings for pressure. But now we come to the third chief matter (the planes and wheels being the two first), the actual flapping wings, which must be fixtures of some sort, for feathering with wood and iron at rapid speed is quite beyond the question; wood and iron would not stand, and flesh and blood would soon be crushed in making the attempt. The shape I recommend for flapping wings can be likened to nothing else that I know of but the combined inner and outer shape of the half of a calf's hoof. Four such shapes should be made of the lightest plating brass, and regulated in size by the radius of the wheels, should be affixed, four to each wheel, with their bowed curves outward. An inspection of the shape will show how readily four of these shapes will make up into a complete self-strengthened wheel, which, with the addition of one single ring put on each wheel externally, tying as it were the shoulders of each hoof together, will be as light and strong as can well be made.

Note then the peculiar action of each separate hoof-shaped wing in beating through the air, as the wheel bearing it rotates on its axle. Beating downwards, as the machine, well-balanced, runs along upon its steam-driven wheels, I think it is evident that each hoof-shape or actual wing beats strongly on the air, while the strength of its beat is greatly aided by the impingement of the gathered air against the rear pair of planes, and so with the successive hoofs, a semicircular powerful driving-ahead beat is readily obtained.

But how about the *practical feathering*, or passing without opposition through the upper semicircle of volation? for if the beat should be continued, action and reaction being equal, nothing would be gained. The answer to this is twofold: first, the centrifugal force, aided by pressure as to its action against the rear planes in rising from the downward beat, flings almost all the compressed air gathered in the hoof right outwards on what may be termed the horizontal line, or under side of the rear planes, and the inner and outer sides of the flapping wing or hoof prevent fresh air from entering its embrace from below; and secondly, when the wing passes above the body plane, it comes altogether into a different current of air, even into a current running forward in the direction in which the hoof is travelling, and so offering no opposition; in fact, part of a little travelling whirlwind behind the double planes stretched out in front. For it will be observed that the pressure of the front planes driven against the air will cause a condensed mass to meet the flapping in the downward beat, and this condensation or cutting off of the horizontal strata of air will cause a corresponding vacuum above and behind the forward plane. Thence it will accrue that whatever air may escape from the front pressure will come over the upper edge of the front plane in a rising curve; and when the machine is at tolerable speed, this curve, ultimately a downward parabolic curve, will be extended so far as that its reflux will fully cover and accompany the wings upon the wheels in the revolution through the upper semicircle of rotation; hence the wheels will, with their wings, beat fully on condensed atmosphere throughout the lower semicircle of rotation, driving the machine forward, and in completing their revolution through the upper semicircle will meet with no resisting opposition, since they will simply pass without any material action along with the returning current of the little natural travelling whirlwind which I have already explained.

Thus, I trust, I have been enabled to show how winged wheels and planes may be combined in furtherance of flight.

As far as I can judge, and as far as leading principles are concerned, omitting the details of the strict proportions and weights of all parts, the only great question remaining to be settled is how to overcome the difficulties attending the use of any of the steam-engines hitherto invented. They are at once too heavy and, in the case of the reciprocating engines, too unsteady for use in a machine requiring perfect smoothness, equability, and steadiness.

I have, however, by me, long-studied plans for a comparatively simple, equably working, light, and powerful engine. But as I have at this time sufficiently ventured to ask your attention, I will defer to speak thereupon till some possible future occasion.*

(*To be continued.*)

MONTHLY NOTES.

THE ARTIFICIAL FORMATION OF MIMETESITE, AND OF CERTAIN CHLORARSENIATES, BY M. LECHARTIER.—The "Comptes Rendus" of the Academy of Sciences, amongst other interesting papers, has one with the above title; and as it appears to us to be so valuable a contribution towards the chemistry of minerals, we give the following note, which we believe first appeared in English in an excellent and new monthly, *The Laboratory*:—M. Lechartier observes, in the first place, that MM. H. Ste.-Claire Deville and Caron, in their memoir on Apatite and Wagnerite, have succeeded in producing artificially, not only these two minerals, but likewise a considerable number of minerals of similar constitution, which they have referred to apatite and wagnerite as types. Thus, apatite being represented by the formula $[(PO)'''_3Ca''_3O_6]_3Ca''Cl_2$, and wagnerite by the formula $(PO)'''_2Mg''_3O_6.Mg''F_2$, these chemists have succeeded in replacing the calcium by lead, strontium, or barium; the magnesium by calcium, manganese, or iron; the chlorine by fluorine; the fluorine by chlorine; and have thus obtained a series of minerals belonging to one or the other of the preceding types. Such are the plumbic, strontic, and baric apatites, and the chlorocalcic, chloromagnesic, and chloro-ferroso-manganous wagnerites. All the apatites crystallize in regular hexagonal prisms, and all the wagnerites in right prisms with rhombic base. M. Lechartier, perceiving that the crystalline form of the mineral was not affected either by the nature of the metal or by the substitution of fluorine for chlorine, was led to suppose that chlorarseniates analogous to apatite and wagnerite might be produced by substituting arsenic acid for phosphoric acid in the artificial preparation of these minerals. This opinion was further supported by the analogy existing between the native phosphates and arseniates with regard to their composition and crystalline form, and by the existence of mimetesite, a chlorarseniate of lead isomorphous with pyromorphite, to the type of which it belongs. Finally, that which afforded the strongest

* Owing to a pressure of matter, we are reluctantly compelled to leave over the discussion on the above paper, as well as other proceedings, till our next issue.

presumption in favour of M. Lechartier's idea, was that M. Debray, in 1865, had obtained an arseniated apatite either by heating arseniate of calcium $(AsO)'''_2Ca''_2H_2O_6$, in a sealed tube to 250° with a solution of chloride of calcium, or by fusing arseniate of calcium with an excess of the chloride. M. Lechartier's expectations have been fully realized. To obtain arseniated apatites and wagnerites, he has recourse to the process previously employed by MM. Deville and Caron for preparing the phosphorated apatites and wagnerites. This process consists in dissolving the metallic phosphate or arseniate at a red heat in the chloride of the metal which forms the base of the salt operated on. The fused mass appears homogeneous, but the desired mineral crystallizes from it on cooling. To introduce fluorine into the substance to be prepared, it is sufficient to mix the chloride which serves as flux with a fluoride of the same metal. By proceeding in this manner M. Lechartier has prepared two arseniated calcic apatites, one containing chlorine, and the other fluorine; an arseniated plumbic apatite (mimetesite); and arseniated strontic and baric apatites. He has likewise obtained arseniated calcic, magnesic, and manganous wagnerites. The formulæ of these compounds are as follows:—

Arseniated Apatites.

Arseniated Calcic Apatites,	$[(AsO)'''_2Ca''_3O_6]_3.Ca''$	Cl Cl
	$[(AsO)'''_2Ca''_3O_6]_3.Ca''$	F F
Arseniated Plumbic Apatite (Mimetesite),	$[(AsO)'''_2Pb''_3O_6]_3.Pb''$	Cl Cl
Arseniated Strontic Apatite,	$[(AsO)'''_2Sr''_3O_6]_3.Sr''$	Cl Cl
Arseniated Baric Apatite,	$[(AsO)'''_2Ba''_3O_6]_3.Ba''$	Cl Cl

Arseniated Wagnerites.

Arseniated Calcic Wagnerite,	$(AsO)'''_2Ca''_3O_6.Ca$	Cl Cl
Arseniated Magnesic Wagnerites,	$(AsO)'''_2Mg''_3O_6.Mg''$	Cl Cl
	$(AsO)'''_2Mg''_3O_6.Mg$	F F
Arseniated Manganous Wagnerite,	$(AsO)'''_2Mn''_3O_6.Mn$	Cl Cl

In studying these several compounds M. Lechartier has verified a law previously established by Deville, namely, that the apatites contain as bases those metals whose carbonates crystallize in the rhombic form, like arragonite; but that the wagnerites, on the contrary, contain metals whose carbonates are rhombohedral, like Iceland spar. Calcium, whose carbonate crystallizes in either form, is likewise capable of forming minerals belonging either to the apatite or to the wagnerite group. This fact is interesting, inasmuch as it shows that the difference observed between spathic and arragonitic metals is more essential than has hitherto been supposed. Apatites differ, indeed, from wagnerites, not only in crystalline form, but also in composition. The several chlorarseniates obtained by M. Lechartier are soluble in nitric acid, a property which renders it easy to determine the chlorine contained in them by means of nitrate of silver. The only difference observed by M. Lechartier between the production of the chlorarseniates and that of the chlorophosphates relates to apatite and wagnerite containing calcium. When phosphate and chloride of calcium are fused together, the product is always a mixture of apatite and wagnerite; but by fusing a mixture of arseniate and chloride of calcium, we may obtain at pleasure either an arseniated apatite or an arseniated wagnerite. At a high temperature the arseniated apatite is alone produced; whereas at a lower temperature, a little below the melting-point of chloride of calcium, nothing but wagnerite is formed. At intermediate temperatures these two bodies are produced simultaneously.

The Fagersta Steel.—Mr. Kirkaldy has of late been conducting some experiments on this material for M. Christian Aspelin, of Norberg and Fagersta, in Sweden. At the Paris Exhibition his specimens are said to have attracted considerable attention, so that a gold medal was awarded to him. The following is a brief summary of the results that Mr. Kirkaldy has obtained:—The average of three bars, marked 1·2, showed that they were capable of bearing an ultimate pulling stress of 85,200 lbs. per square inch, the ratio of elasticity to fracture being 73·1 per cent., and the ultimate permanent extension 1·8 per cent. The average of a second set of bars, marked 0·9, showed that they were capable of bearing an ultimate pulling stress of 106,613 lbs. per square inch, the ratio of elasticity being 59·4 per cent., and the ultimate permanent extension 5·1 per cent. With a third set of bars, marked 0·6, the figures were—102,632 lbs., 56·6 per cent., and 6·6 per cent. respectively; and with a fourth set, marked 0·3, they were—61,312 lbs. 70·3 per cent., and 16·5 respectively. The three first sets of bars fractured suddenly at the stress named, whilst the last set fractured slowly. The same bars were next tested to ascertain the thrusting stress. The lengths tested were one, two, four, and eight diameters. In all cases the pieces of one diameter submitted to a stress of 200,000 lbs. per square inch, the ultimate depression for the four marks—1·2, 0·9, 0·6, and 0·3—being 20·9 per cent., 22·4 per cent., 26·0 per cent., and 48·1 per cent. respectively. As the length of the section increased, of course, the thrusting stress which it would bear diminished, but in every instance the results were really admirable. Eight diameters of the 1·2 bar showed that it could bear an ultimate thrusting stress of 102,173 lbs. per square inch, the ultimate permanent depression being about 2½ per cent.; the 0·9 iron sustained 95,207 lbs. to the inch, and the ultimate permanent depression was 3·6 per cent.; the 0·6 iron sustained 84,827 lbs. to the inch, and the ultimate permanent depression was 4·0 per cent.; and the 0·3 iron sustained 47,513 lbs. to the inch, and the ultimate permanent depression was 4·8 per cent. The next series of experiments with these bars was made with the object of ascertaining the shearing stress which they would bear; the nature of the test being such as the iron would have to submit to when employed as a bolt. The bars were passed through three orifices, so that the power was applied to the two ends in one direction and to the centre in the other. The test pieces were fractured in each case, the four marks of iron bearing respectively 61,412 lbs., 79,737 lbs., 71,648 lbs., and 45,410 lbs. per square inch. To ascertain the twisting stress which the bars would bear, the centre of the specimen was held firmly and twisted in one direction, and the ends were twisted in the other; the 1·2 iron sustained an ultimate stress of 2120 lbs. per square inch, whilst the ultimate torsion was ·0291 (one turn being equal to 1·000); for the 0·9 iron the corresponding figures were 2336 lbs and 0·793; for the 0·6 iron, 2261 lbs. and 1·021; and for the 0·3 iron, 1520 lbs. and 3·219. In each case the length of the lever was 12 inches, and the length for torsion 8 diameters. The last test of these bars was for trying the bending strength; the supports were 20 inches apart, the reverse power being applied in the centre. The total average ultimate stress borne by the four descriptions of bars was 32,589 lbs., 43,833 lbs., 38,145 lbs., and 25,283 lbs. respectively, and the ultimate deflection 0·78 inches, 1·49 inches, 3·31 inches, and 5·11 inches respectively. The next series of experiments was for ascertaining the resistance to extension, set, and rupture, under a pulling stress, and to permanent extension under a thrusting stress. Under the pulling stress, the four samples bore an ultimate stress per square inch of original area of 53,924 lbs., the permanent set being ·261, at 52,000 lbs.; 51,640 lbs., the permanent set being ·577 inch at 50,000 lbs.; 47,392 lbs., the permanent set being 1·15 inch at 46,000 lbs.; and 46,896 lbs., the permanent set being 1·56 inch at 46,000 lbs., respectively. Submitted to the thrusting stress, the whole of the samples remained uncracked under a stress of 200,000 lbs., the ultimate permanent depression in the four billets being 51·4 per cent., 50·6 per cent., 52·6 per cent., and 52·7 per cent., respectively. And lastly, a series of experiments were made to ascertain the mechanical properties of nine rolled plates of various degrees of hardness. The results obtained were—with 0·9 iron, ultimate pulling stress per square inch of original area, 101,328 lbs.; of fractured area, 117,653 lbs.; extension, 9·3 per cent.: with 0·6 iron the corresponding figures were 97,011 lbs.; 121,257 lbs.; and 11·3 per cent.: and with 0·3 iron, 70,790 lbs., 130,313 lbs., and 15·5 per cent. respectively. Under a bulging stress the 0·9 iron bulged 2·30 inches, with an ultimate stress of 111,000 lbs.; the 0·6 iron bulged 2·57 inches, with an ultimate stress of 120,000 lbs.; and the 0·3 iron bulged 4·04 inches, with an ultimate stress of 99,096 lbs. The ultimate punching stress sustained by the 0·9 iron was 75,752 lbs. per square inch; by the 0·6 iron, 74,217 lbs.; and by the 0·3 iron 51,426 lbs. The thickness of the plates in the two latter series of tests averaged 0·275 inch for the 0·9, ·28 for the 0·6, and ·26 for the 0·3. In the bulging test the diameter of the aperture upon which the plate to be bulged was placed was 10 inches; and in the punching test, the diameter of the punch used was 1·128, or 1 square inch.

University of Glasgow.—At a meeting of the senate of this University, held last month, the following candidates received certificates of proficiency in engineering science:—William E. Rich, C.E., John Isaac Thornycroft, C.E., Andrew A. Haddin, C.E., Zaccheus Walker, C.E., John Wood, C E. The following candidate was reported by the board of examiners to have completed part of the course of study and examination, viz., mathematics, natural philosophy, chemistry, geology, and civil engineering and mechanics—George Dunlop.

Metallurgy in Belgium.—It appears extremely probable that a wider field for the development of the metal trade of Belgium will shortly be opened up in the east. The transit to Persia and the extreme East is now made, for the most part, by way of Trebizonde and Erzeroum to Tauris; but the route is long, costly, and difficult. The Russian government is, it appears, desirous to attract this traffic over its territories; and it was for this object that the port of Poti, situated at one end of the Black Sea, was created, in some measure, a few years since, and Russia has now decreed a railway intended to unite Poti to Tiflis. This line is the first section of the great Indian route, which is to run from Tiflis to Tauris, *viâ* the Aran, towards Teheran and the Indian peninsula, following the telegraphic network already established in those districts. Last year two young Belgian engineers made an exploratory journey in the north of Persia, in order to examine the means of forming a road which must precede the establishment of a line of railway from Tiflis to Tauris. Belgian houses have negotiated the supply of all the plant required for the proposed line from Poti to Tiflis; and the syndicate of Belgian forge-masters will, in all probability, obtain this important affair. While the north of Persia is thus about to be united to the east, and while Belgium is making efforts to promote this object, other enterprising Belgians have attacked the south of the Persian empire, and several steamboats intended for the navigation of the Euphrates, between Bagdad and Bassorah, and on the Persian Gulf, have been constructed by the Cockerill Company; all the plant of this extensive enterprise has just arrived at Antwerp, in order to be embarked for Bassorah. It is also proposed to send out to Kirmanchair a whole sugar manufactory, a concession of which has been obtained from the Persian government. The hopes of the young king of Belgium, who takes much interest in the development of Belgian commerce and industry in the extreme East, are thus in a fair way of realization.

The Gold Ores of Canada.—Messrs. Wyckoff & Co., of Greenpoint, Long Island, have of late experimented with ore from the Richardson mine, at Madoc Township, Hastings County, Canada West. The Wyckoff process consists in first reducing the ore to the utmost possible degree of fineness, and then treating it, in connection with mercury, with salt water and steam. It is claimed that in this manner a more complete union of the gold with the mercury is obtained than can be done by any other known process. About 160 lbs. of earth, taken from the crevices of the rock, were found to yield 18 ozs. of gold of twenty-three carats fineness, valued at 4*l.* per oz., which is equivalent to about 1300*l.* per ton of earth. The formation in which this gold is found is traceable over a tract of country which the *Mining Journal* states is about 80 miles in length by 50 miles in breadth.

Inverse Filtration.—A method of inverse filtration has been brought out in Philadelphia, which under some circumstances would be more useful than the direct way as at present practised. It may be thus described:—Cover the mouth of a funnel with a piece of calico or muslin, and plunge the funnel with the mouth downwards in the vessel of liquid to be filtered. To the stem or neck of the funnel, which is then uppermost, attach an india-rubber tube, whereby the whole is converted into a syphon, through which the liquid, after rising through the muslin, flows rapidly, leaving the impurities behind.

Wood Fibres.—Payen, the chemist, in an interesting paper to the Academy of Sciences on the "Structure and Constitution of Woody Fibres," concludes thus:—1. The subject of substitutes for textile fibres is one of great interest, and promises a gradual increase in the consumption of paper, which naturally follows the happy impulse given to general education. 2. In a scientific point of view, it is proved by a considerable annual consumption, representing more than one-tenth of the total amount of the raw materials of paper, that the cellulose extracted from various and even from ligneous fibre, more or less covered with other matters, is chemically identical. 3. That the less compact spongy cellulose forming the matter of ligneous incrustations may be detached from the cells by means of acids, which convert it into glucose capable of undergoing alcoholic fermentation. 4. That thus two products may be obtained from the wood of various trees; alcohol, and membrane of cellulose sufficiently strong, flexible, and pure, to be used in making all kinds of paper, and even for the whitest kinds, in the proportion of 80 per cent. 5. That this experimental demonstration is equally interesting in an agricultural point of view, for it opens up a new market for the products of plantations of *coniferæ*, which have the special quality of rendering productive and healthy the immense tracts of waste country which are to be found in France.

Anchors and Chain Cables in France.—The importation into France of anchors does not take the development that might have been expected from the facilities afforded under the new bill on the Merchant Navy, and from the fact that anchor-making is a branch of industry in which that country is backward. The import, indeed, is actually declining. In the first five months of the present year only $26\frac{3}{4}$ tons of anchors of a quarter ton in weight and upwards were received by the French for their own consumption, whereas in the corresponding period of last year they took $40\frac{1}{4}$ tons; and in that of 1865, $36\frac{1}{2}$. Of anchors of less than a quarter ton in weight, they received in the first five months of the year $132\frac{1}{4}$ tons, to $148\frac{1}{2}$ in the corresponding period of last year, and 166 in that of 1865. The return from which we quote these figures, and which is a French one, does not specify what countries supplied the first-named class of anchors, but no doubt the greater part was sent from England. As to smaller ones, the return records that nearly all were from her. It would appear that anchors go through France to other countries, inasmuch as, though the French only took for consumption the quantities above-mentioned, there arrived in France, in the five months of the present and the two preceding years, $45\frac{1}{4}$, $71\frac{1}{4}$, and $51\frac{3}{4}$ tons of anchors of a quarter ton in weight and upwards, and 154, $176\frac{3}{4}$, and $196\frac{1}{2}$ of smaller ones. As to chain cables, the demand in France has considerably increased. In the first five months of this year the French received for their own use $109\frac{1}{4}$ tons; whereas in the corresponding period of 1866 they only took 49 tons, and in that of 1865, $50\frac{1}{2}$. Of this article, also, it appears that other countries get supplies *viâ* France, the total arrivals in the three periods being (including the preceding figures) 262, 71, and $70\frac{1}{4}$ tons. The countries which supplied the cables are not specified. The return estimates the value of the anchors at 96,379 francs in the five months of 1867, 114,408 francs in those of 1866, and 122,602 francs in 1865. The value of the chain cables is put down, for the three periods, at 53,536 francs, 24,018 francs, and 24,632 francs.

Water Supply of Glasgow.—The following letter, addressed to the *Lancet*, gives some interesting particulars relative to the purity of water for domestic purposes:—"We have recently made an examination of the Loch Katrine water as supplied to Glasgow. The water was taken from one of the mains in Glasgow. The result of the examination is calculated to surprise many persons, for the Loch Katrine water has often been cited as a model water. We find that 1,000,000 parts of this water contain putrescible organic matter corresponding to 0·13 parts of ammonia. The numbers for the New River water, which supplies some parts of London, are 0·09, and for the Southwark and Vauxhall Company's water, taken from the Thames, high up the river, 0·20. The Caterham water, and also a spring in the greensand, near Dorking, contain no putrescible organic matter. These facts point to the propriety of seeking for a supply of drinking water from springs, and not from rivers and lakes. We are, &c., J. Alfred Wanklyn, Ernest T. Chapman, Miles H. Smith. London Institution, Finsbury Circus, July 1st, 1867."

How Paper is Made in China.—A curious book, going to English ears by the equally odd name of "Shien-Kong-Khaiwe," has fallen into the hands of M. Stanislas Julien, who quotes from it in *Le Moniteur de la Papetier Française*, from which the *Paper Trade Review* has recently given the following translation:—After enumerating the various materials used in this manufacture, which consist of the bark of various trees and plants, the writer goes on to speak of the bamboo fibre, which is commonly used for all the ordinary Chinese papers. The thickest of the paper made from bamboo is called "ho-tchi," and is used for burning in the joss-houses, and another sort called "pao-kotchi," used for wrapping fruits. All the bamboo paper is made in the southern part of the country; but it is in the province of Fokien that the manufacture is most flourishing. When the first shoots of the bamboo begin to show themselves, all the plantations on the mountains devoted to their culture are visited, and the preference is given to those stems which are about to put out branches and leaves. After the 5th of June the bamboos are cut down and divided into pieces of from 5 to 7 feet in length. A pit is dug in the earth and filled with water, and the canes are laid in it to steep, while other bamboos serve as tubes to conduct water from the mountain streams to the pit. After soaking for several weeks, the canes are beaten with mallets, and the thick bark and green skin removed. Under the green skin appear filaments resembling a fine sort of hemp; these are treated with lime and water in a vat where the liquid is raised to a certain temperature, and kept in that state for about a week. The filaments of bamboo are then removed, and washed in cold water; after which they are passed through a lye of wood ash, and transferred to a boiler. These processes are repeated until decomposition commences, and the filaments begin to grow putrid. They are then consigned to a huge mortar, and pounded into pulp by water power. This pulp is thrown into a wooden trough of the size required for the sheets of paper, and while there is a considerable quantity of water above the pulp, the tchi-zo, or bleaching powder, is added to the mass. The pulp is then raised upon a web of silk tissue on a light wooden frame. The workman takes this frame in his hands, and dips out the *paté* in a sufficient quantity to make either a thick or a thin paper. As soon as the liquid *paté* floats to the surface of the form, the water runs off at the corners, and the workman turns the sheet over on to a large table, where, when a sufficient number of sheets is deposited, a plank is placed over them, and the paper is pressed. Each sheet is then raised separately and dried by the heat of a furnace in a sort of kiln built for the purpose. Pao-ko-tchi is made by mixing the bamboo filament with rice straw gathered after the harvest, while the material of coloured papers used for letter writing is the finer part of the bamboo fibre. The most highly esteemed paper of this sort is called "kouan-kien," and is used by wealthy persons for visiting cards and notes. In making paper from tree bark, the material is obtained from a tree called "*tchou*" (Broussonetia paperrifera), and about 60 pounds of this bark is mixed with 40 pounds of bamboo fibre. These are macerated in water, and treated with lime before they are reduced to pulp. For some time past it has been attempted to substitute rice straw for a portion of the bamboo fibre. This bark paper is remarkably tough, and so fibrous that when torn it has a textile appearance, while this similarity to a woven fabric is increased by the evident difficulty of tearing it transversely. The best of this paper is used in the Imperial Palace, and large quantities of the stronger sort are used for the manufacture of window-blinds and other articles for which woven substances—cotton, silk, or linen—are used in European households, the colour being added to the pulp before the manufacture is complete, so that after-colouring is unnecessary. Paper made of the bark of the mulberry tree is called "sang-jang-tchi," and is remarkably strong and thick. This paper is extensively used in the breeding and culture of silkworms; for the manufacture of umbrellas, fans, and varnished fire-screens, paper of a thinner pulp is used. Bark paper intended for painting is passed through alum water, to destroy the fine filaments which are so commonly found on the surface. The face of the sheet which lies on the silk tissue of the form is the right side of the paper, the floating particles of pulp leaving the upper surface singularly rough and irregular. At Japan paper is made without any form at all. A large smooth blue stone is heated on a stove, and on the surface of this stove the liquid *paté* is painted with a great bush (? brush), the sheet of paper being thus immediately made and dried.

APPLICATIONS FOR
PROVISIONAL PROTECTION FOR INVENTIONS
UNDER THE PATENT LAW AMENDMENT ACT.

☞ When the city or town is not mentioned, London is to be understood.

19th July, 1867.

2114 J. Hargreaves, Appleton-within-Widnes—Utilizing waste material of iron and steel
2115 J. W. Butler and E. Edwards, London—Floating apparatus
2116 J. Rogers, King's Cross Road—Fastenings
2117 G. T. Bousfield, Brixton—Bolsters for spinning machines.—A com.
2118 P. H. Metham, Rotherhithe—Rudder

20th July, 1867.

2119 J. Saxby, Kilburn—Railway points and signals
2120 K. H. Cornish, Saint Mary Axe—Entrenching tools
2121 J. Hargreaves, Appleton-within-Widnes—Soda and potassa
2122 T. Bromwich, Bridgnorth—Allowing carbon to escape from casks
2123 C. F. Whitworth, Saddleworth—Preventing accidents at junctions
2124 A. Budenberg, Manchester—Pipes and tubes.—A com.
2125 W. Taylor, Nursling—Ventilating hothouses
2126 W. G. Creamer, Russell Square—Automatic apparatus
2127 A. Sezille, Noyon Town—Treating dry peas
2128 R. Shaw and J. Strik, Leeds—Brickmaking machinery
2129 W. Potts, Handsworth—Suspending pictures
2130 J. Hooper, Mosely—Ventilators

22nd July, 1867.

2131 B. P. Franzoni, Oxford Street—Hardening plaster
2132 T. A. Briethaupt, Paris—Manufacturing extract of hop
2133 H. Lea, Birmingham—Taps and valves
2134 W. R. Lake, Chancery Lane—Cleaning boilers.—A com.
2135 J. Walker, City Road—Washing bottles
2136 H. V. S. Sakunlunski, Portland Place—Transferring devices
2137 W. E. Newton, Chancery Lane—Brewing.—A com.
2138 D. Welsh, Glasgow—Looms for weaving

23rd July, 1867.

2139 E. Tomlinson, Hatton Garden—Ornamenting and printing
2140 J. H. Johnson, Lincoln's Inn Fields—Nets and netting.—A com
2141 W. Dennis, Aldermanbury—Letter boxes
2142 H. A. Dufrene, Paris—Preserving iron.—A com.
2143 W. Easterbrook, Kilburn—Actuating railway points
2144 J. Marley, Darlington—Preventing the fall of cages used in mine shafts
2145 S. Bonsall, Aldergate Street—Spring bed bottoms
2146 S. Bonsall, Aldergate Street—Tanning
2147 Sir W. Thomson, Glasgow—Telegraphic recording instruments
2148 W. Greeves, Barnsbury—Cutting tenons

24th July, 1867.

2149 R. Lakin, Manchester—Aerial locomotion
2150 W. Simpson, Rosherville, and W. Howitt, Manchester—Roofs
2151 W. Betts, City Road—Capsules.—A com.
2152 H. Aitken, Falkirk—Manufacture of coke
2153 R. B. Roden, Usk—Breech-loading fire-arms
2154 T. Prideaux, Sheffield—Stove grates
2155 A. M. Clark, Chancery Lane—Reciprocating motion.—A com.

25th July, 1867.

2156 S. Turton, Heaton Norris—Communicating on railway trains
2157 W. Howes and W. Burley, Birmingham—Securing lamps
2158 C. H. Murray, Southwark—Moulding clay
2159 C. T. Moulan, Verviers—Movable joints
2160 W. E. Newton, Chancery Lane—Mouldboards for ploughs.—A com.
2161 A. Wilson, Sheffield—Casting ingots
2162 J. Brown, Howburn, and W. Lillie, Tweedmouth—Reaping and mowing machines
2163 W. Wood, Monkhill—Producing fibres from rags
2164 A. Mackie, Warrington—Distributing type
2165 T. M. Almond, Scarborough—Signalling at sea
2166 C. E. Brooman, Fleet Street—Manufacture of cast steel—A com.
2167 C. E. Brooman, Fleet Street—Cartridges cases.—A com.
2168 G. L. Barens and J. F. Ladougne, Paris—Fire-arms

26th July, 1867.

2169 J. Edge, Bolton-le-Moor—Steam engines
2170 C. Silvy, Bayswater—Photographic apparatus
2171 R. Reid and E. H. Craigie, Kilmarnock—Reclining chair
2172 G. B. Northcote, Honiton—Charging cartridges
2173 E. Smith, Hamburg—Gas regulators

27th July, 1867.

2174 J. Smith and W. Schofield, Baxenden—Elastic roller
2175 E. A. Rippingille, Holborn Hill—Distilling mineral oils
2176 T. Reid, Monkton Mill—Implements for digging potatoes
2177 W. E. Gedge, Wellington Street—Slate-cutting machine.—A com.
2178 E. T. Hughes, Chancery Lane—Propelling steam vessels.—A com.
2179 W. E. Newton, Chancery Lane—Gas meter.—A com.
2180 P. A. Rohart, Duhord—Manufacturing gases
2181 A. Jack, Maybole—Apparatus for digging potatoes
2182 H. Chamberlain, Wakefield—Hot blast stoves
2183 G. Franklin, Cannon Street—Ship's compasses
2184 T. Jones, Birmingham—Locks
2185 J. Wood, Birmingham—Treating iron
2186 E. Ravenscroft, Birmingham—Lamps
2187 A. Macfie, Birmingham—Apparatus for supporting lines for drying clothes

29th July, 1867.

2188 W. L. L. Leaver, Blackburn, and A. Smalley, Preston—Lighting fires
2189 T. Greener and W. Ellis, Darlington—Manufacture of iron
2190 A. M. Clark, Chancery Lane—Projectiles
2191 W. R. Lake, Chancery Lane—Hulling rice.—A com.
2192 G. Davies, Serle Street—Insulators.—A com.
2193 P. G. B. Westmacott, Elswick—Cranes
2194 D. Hodge, Hatton Garden, and R. C. Witty, Dalston—Making gas
2195 J. H. Wyatt, Charing Cross—Studs and buttons
2196 B. F. Stevens, Henrietta Street—Burning petroleum.—A com.

30th July, 1867.

2197 A. Holloway, Birmingham—Elastic clasp
2198 A. Watt, Putney—Fertilizing compost
2199 J. B. A. Menage, Farringdon Road—Lamps
2200 J. Jones, Little Bolton—Extinguishing fires
2201 W. Gadd, Nottingham, and J. Moore, Manchester—Looms for weaving
2202 J. Haworth, Denton, and E. Hamer, Manchester—Rollers
2203 J. H. Brown, Richmond, and W. Bull, Chancery Lane—Manufacturing hats
2204 A. Murray, Portsmouth—Hauling vessels into water
2205 C. Mayo, Oxford—Steering vessels
2206 A. James, Redditch—Needle cases
2207 S. M. Martin, Pinner, and S. A. Varley, Holloway—Signalling upon railway trains

31st July, 1867.

2208 B. Dobson, Bolton, and J. Cocker, Chadderton—Spinning machine
2209 B. Dobson and W. Slater, Bolton—Carding engines
2210 M. Puddefoot, Greenwich—Plough
2211 M. J. Fearnley and C. Smith, Macclesfield—Looms for weaving
2212 J. M. Hockings, Poplar—Condensing smoke
2213 G. Gordon, San Francisco—Manufacturing sugar
2214 W. R. Lake, Chancery Lane—Manufacturing weavers' harness.—A com.
2215 J. C. C. Azemar, Lawrence Pountney Hill—Boxes for holding paper
2216 C. E. Brooman, Fleet Street—Fire-arms
2217 J. Saxby, Kilburn—Locking railway points

1st August, 1867.

2218 W. Snell, Clement Inn—Engraving machine.—A com.
2219 F. A. Calvert, Manchester—Cleaning fibrous materials
2220 J. H. Johnson, Lincoln's Inn Fields—Umbrellas.—A com
2221 F. H. Holmes, Paris—Producing electric light
2222 D. D. Kyle, Victoria Street—Signalling in railway trains
2223 R. B. Boyman, Stockwell Park Crescent—Propelling vessels
2224 J. Quin, Leyland—Preparing hoses
2225 R. Newhall, Astwood Bank—Needle cases
2226 W. R. Lake, Chancery Lane—Pocket knives.—A com.
2227 W. R. Lake, Chancery Lane—Fire-arms.—A com.
2228 W. Tranter, Birmingham—Fire-arms
2229 J. E. Nelson, Brook House—Conveying through the air
2230 S. Higgs, Penzance—Safety lamps
2231 J. Birch, Birmingham—Manufacturing wax matches

2nd August, 1867

2232 J. Poole, Chelsea—Forming shafts with india-rubber surfaces
2233 F. L. H. Danchell, Horwick—Drying peat
2234 J. Edwards, Victoria Chambers—Locking signals
2235 B. Harlow, Macclesfield—Boilers
2236 J. H. Johnson, Lincoln's Inn Fields—Hydraulic lifts.—A com.
2237 E. T. Marler, Basinghall Street—Clarifying sugar.—A com.
2238 J. Dewar, Kirkcaldy—Preserving food
2239 E. A. Kirby, Gordon Square—Dispensing medicines
2240 W. Horton, Sheffield—Forge hammers
2241 T. Allen, Adelphi Terrace—Submarine cables
2242 J. G. Tongue, Chancery Lane—Brakes.—A com.

3rd August, 1867.

2243 J. Smith, Cheetham—Cleansing textile fabrics
2244 J. Elce, Manchester, and T. Elce, Via Gellia—Spinning machinery
2245 C. D. Abel, Chancery Lane—Gas and air engines.—A com.
2246 R. Bewley, Uttoxeter—Rotary pumps
2247 C. Touaillion, Paris—Utilizing feathers
2248 J. Russell, Manchester—Flattening saws
2249 A. Budenberg, Manchester—Indicating steam.—A com.
2250 J. F. and F. Fenton, Sheffield—Coffee injector
2251 W. R. Grace, Brooklyn—Harrows.—A com.
2252 J. T. Hatfield, Hoboken—Watch cases.—A com.
2253 G. W. Dinsdale, Upper Norwood—Traps for water-closets
2254 W. W. Hughes, Hyde Park—Propelling vessels
2255 W. Wilson, Newcastle-upon-Tyne—Felting machines

5th August, 1867.

2256 J. Angus, Regent's Park—Lamps
2257 L. V. Hue and C. Roziere, Paris—Moulding subjects in glass
2258 J. Dale, Upper Thames Street—Refrigerator
2259 W. J. Pughsley, Llantarnam—Obtaining sulphuric acid
2260 A. C. Bamlett, Thirsk—Mowing machines
2261 C. de Negri, Belsize Road—Reducing wood to shreds
2262 J. G. Tongue, Chancery Lane—Carriages.—A com.
2263 G. Schneider, Paris—Fire-arms
2264 E. Heaton, Langely Mill—Blast furnaces
2265 W. Prangley, Salisbury—Athletic exercises
2266 J. Lockwood, Leeds—Steam-boiler furnaces

6th August, 1867.

2267 T. Whittaker and M. Rourke, Manchester—Waterproof paper
2268 J. Bolland, Blackburn—Steam boilers
2269 A. M. Clark, Chancery Lane—Reeds for weaving.—A com.
2270 T. Luthringer, Lyons—"Geranosine"
2271 E. J. W. Parnacott, Leeds—Trenail
2272 H. H. Murdoch, Staple Inn—Sorting corn.—A com.
2273 T. Kyland, West Bromwich—Pulleys
2274 M. Jones, Worcester—Kitchen ranges

7th August, 1867.

2275 E. Cornely, Paris—Sewing machines
2276 C. M'Dermott, Brixton—Eyelet fastener.—A com.
2277 A. J. Paterson, Edinburgh—Fire-arms
2278 T. C. Marshall, Jarrow, and Hugh Stewart, Liverpool—Raising water
2279 R. H. Michell, Charing Cross—Dredging machinery
2280 M. Hamer, Manchester—Cutting india-rubber thread
2281 T. S. Cressy and J. Webb, Burton-on-Trent—Shrinking cloth
2282 E. T. Horsely, Alfreton—Treating cast iron
2283 J. P. Binns, Chatterton—Paper bags
2284 G. Holcroft and W. N. Dack, Manchester—Steam engines
2285 A. M. Clark, Chancery Lane—Metallic alloy.—A com.
2286 C Benson and J. Barker, Leeds—Preparing moulds
2287 H. W. Withers, New Cross—Boats
2288 T. Wirth, Frankfort-on-the-Maine—Stamping letters.—A com.
2289 J. E. T. Ludeke, New Cross—Obtaining motive power
2290 W. R. Lake, Chancery Lane—Printing presses

9th August, 1867.

2291 T. J. Baker, Newark—Manufacturing flour
2292 W. R. Dawson, Windsor Chamber—Smelting iron sands
2293 T. J. Seymour, New York—Boxes for holding twine
2294 H. A. Avery and G. Penabert, Paris—Preventing incrustation in boilers
2295 W. J. Miller, Birmingham—Knives and forks
2296 R. Heathfield, Birmingham—Cut nails.—A com.
2297 C. Hohgrefe, Brunswick—Chimney tops

10th August, 1867.

2298 H. A. Bonneville, Paris—Stringed instruments.—A com.
2299 H. B. Barton, Manchester—Winding machine.—A com.
2300 J. Davenport and J. Kitson, Bradford—Slide valves
2301 E. Newby, Sun Street—Shackles
2302 G. Hodgson, Bradford—Looms for weaving
2303 A. M. Clark, Chancery Lane—Refrigerating apparatus.—A com.
2304 G. Warsop, Nottingham—Cleaning windows
2305 R. Girdwood, Edinburgh—A composition for destroying vermin on sheep
2306 R. Edmondson, Blackburn—Pickers for looms
2307 T. H. Holmes, Paris—Electric light

12th August, 1867.

2308 C. D. Abel, Chancery Lane—Removing sulphur from metal.—A com.
2309 E. Mounier, Paris—Penholders
2310 E. Courtin, George Lane—Splitting sarsaparilla.—A com.
2311 A. Turner, Leicester, and W. Hemsley, Melbourne—Gloves and stockings
2312 J. H. Evers, Altona—Generating steam
2313 E. B. Wilson, Bolton—Furnaces
2314 A. M'Dougall, Manchester—Extracting sulphur
2315 J. Shanks, Arbroath, and J. Cargill, Leadenhall Street—Mowing machines
2316 J. J. Rawlings, Melbourne, and H. Wilkerson, Eversden—Washing coprolites
2317 W. Sivenson and J. C. Heilmann, Glasgow—Securing railway tickets
2318 W. T. Eley, Gray's Inn Road—Rendering cartridges waterproof

13th August, 1867.

2319 G. Davies, Lincoln's Inn—Washing sugar.—A com.
2320 H. T. Everist, Kidderminster—Manufacture of gas
2321 Edward Score, Hampstead—Quoins or wedges
2322 John James Bright, Bristol—Actuating screw propellors
2323 G. and J. Pilling, and Frederick Jennings, Halifax—Saving edges of fabrics
2324 B. F. Sturtevant, West Roxbury—Blowers for furnaces
2325 H. M. Mellor, Nottingham—Knitting frames
2326 S. R. Wybrants, Dundee—Utilizing waste materials
2327 A. Swan, Kirkcaldy—Recovering lees
2328 M. F. Halliday—Breech-loading fire-arms
2329 J. Badger, Worcester—Cooking ranges
2330 C. E. Flower, Stratford-upon-Avon—Cooling brewers' worts
2331 J. Fawcett, Kirton-in-Lindsey—Cattle feeding
2332 T. Walker, West Hartlepool—Cutting grooves

14th August, 1867.

2333 W. Turney and J. Ackroyd, Nottingham—Jacquard machinery
2334 W. B. Leachman and J. Holyroyd, Leeds—Pumping fluids
2335 A. M. Clark, Chancery Lane—Securing bayonets on fire-arms
2336 Charles Holliday, Huddersfield—Printing fabrics
2337 J. A. Jones, R. Howson, and J. Gjers, Middlesborough-on-Tees—Heating iron
2338 C. F. Bower, Brighton—Combined bed, couch, and chair
2339 W. Betts, City Road—Capsules for bottles
2340 W. Betts, City Road—Capsules for bottles
2341 G. Buxton, Tenton, and S. Bann, Crewe—Carriages for railways and other roads
2342 A. W. Williamson, Fellows Road—Lamps
2343 H. Bessemer, Cannon Street—Throwing projectiles
2344 J. T. Way, Kensington—Manufacture of manure
2345 J. Peacock, Rochford—Cleaning barrels or casks

15th August, 1867.

2346 F. H. Wenham, Clapham—Heated air engines
2347 F. Bushby, Manchester—Pill making machines
2348 J. Cosgrave, Liverpool—Bakers' ovens
2349 R. Cleland and R. Cunningham, Paisley—Imitation horse-hair fabrics
2350 E. Ormerod, Atherton—Minerals from mines
2351 A. F. Baird, Pimlico—Earth closet
2352 H. Bodart and Alfred Sigodart, Gosselies—Propelling vessels
2353 W. R. Lake, Chancery Lane—Securing bales of cotton

16th August, 1867.

2354 G. Clark, Southwell House—Fire escapes
2355 J. Day and W. Dorber, Manchester—Vehicles
2356 Michael Henry, Fleet Street—Paper pulp.—A com.
2357 Hyman Frankenburg, Skinner Street, and S. Phillips, Whitechapel—Leggings and gaiters
2358 R. Joseph, Westminster Road—Stays or corsets
2359 T. Jackson, Portman Square—Pianofortes
2360 J. W. Dudley, Bermondsey—Cutting corks
2361 J. Wavish, Torpoint—Heating of greenhouses
2362 A. Leveson, Manchester—Coverings for perambulators
2363 L. A. Bainee and M. J. Sibillat, Paris—Spring mattresses
2364 A. Lees, Oldham, and W. H. Rhodes, Hollinwood—Spinning cotton
2365 T. Sagar and T. Richmond, Burnley—Looms for weaving
2366 J. Holyroyd, Leeds, and W. Fieldhouse, Balley—Spinning machinery
2367 M. Frow, Leake—Reaping machines

ON THE WAR MATERIAL EXHIBITED AT PARIS.

(*Continued from p.* 164.)

AUSTRIA exhibits also in the most complete and unreserved manner her systems of torpedoes: those by which, during the late Italian war, she blocked up the entrances both to Venice and to Pola. The mere idea of a sub-aqueous torpedo is not very recent. Their use was even attempted against our own ships of war by the Americans in 1814, if not employed even earlier by others. They were largely employed by the Russians in 1854–55, and a detailed plan was at that period laid before our Admiralty for destroying by their means, upon a very large scale, the underwater dam or obstruction to the approach of Cronstadt on the north side, which consisted of a line of great timber cribs filled with stones, which had been brought out upon the ice and sunk in a line between the coast of Finland and the fortress. Had the war continued, it was intended to have employed the proposed method, the details of which exist now in the Admiralty archives. In the Confederate war, also, torpedoes were largely employed by the South, and were constructed with great ingenuity and skill, though with miserable material. Here, as in the cases of telegraphy and of distant illumination, a new world was opened as soon as electricity became the every-day working tool it is now. The uncertainty of ignition and the dangers of premature explosion at once vanished, which were the real obstacles to the use of this formidable instrument, destined hereafter to become one of the most potent means of defence, for the weak against the strong, in rivers, harbours, and coasts, &c.

Torpedoes, as they now have become "*perfectionnées*," if not perfected, are divided into two great classes: those which fire themselves as soon as they or something belonging to them come in contact with a floating object, and those which are fired by an observer from the shore. The two systems may be combined, so that in case the torpedo fails to be fired by the passing object (ship or the like), it shall still be competent for the watcher upon the shore instantly to take up the task and fire it before the ship can have got beyond range. Self-acting torpedoes were employed in a double rank at the harbour of Pola; but they were not fired by fuzes, as was the case with many of the Confederate torpedoes, but by electricity: all the floating cases of powder or of gun cotton were in connection by submerged insulated wires with the shore, and with a constant source of electricity there. The outside of each torpedo case had several projecting studs; the gentle pressure of an advancing ship's hull upon any one of these at once broke and re-established the galvanic current; at this moment a spark passed and ignited the explosive matter. If the torpedo was luckily placed with respect to the ship's hull, the latter was sure to be broken in and the ship sunk. The great difficulty, or rather the uncertainty as to the effect of torpedoes, lies in this, that a cushion of even a very few feet of water is sufficient to buff the blow, and merely to produce a heave and ugly shake, or some leakage. If, on the contrary, the torpedo be close to the ship's hull, it is quite amazing how small a quantity of powder will burst in a huge portion of the bottom or even the arched bilge of even the strongest iron or timber built ship. This arises from the molecular properties of water in relation to the time in which the shock of the explosion acts. Water is homogeneous; it is to any sudden impulse a nearly absolutely solid body. Although it can transmit a vibration such as an earthquake shock, or *the jar* from the explosion of the torpedo, or an audible sound through itself at the rate of more than 4000 feet per second, by virtue of its *elasticity*, which, although nearly perfect, acts through an excessively small range, water being very slightly compressible (only about 47 parts in 1,000,000 for each atmosphere), yet, owing to this very fact of small compressibility, the blow of the explosion is transmitted so completely to the most distant parts of the body of fluid at the same instant, that at the focus of explosion it becomes a fulcrum to its effort, equal to that of a solid anvil of the same density on water. Hence the entire force of the explosion is spent upon the yielding side, that of the ill-fated ship.

The second system of torpedoes, those fired only by the hand of the man watching the approach of the ship from the shore, was that employed at Venice, and laid down in the Malamoco channel of the harbour. If a line be marked out across such a channel, and that torpedoes be laid down at equal and close intervals across for its entire length, and that all these are in such electric communication by submerged wires that any one or more can be instantly fired; then if these wires at the firing point on shore, all under the hand of the operator, who sees before him a commutator, by which he can distinguish and at once fire any torpedo in the line, we have one part of the system complete. But we must have more to make it perfect. He must be able to determine exactly the position of the ship in relation to the line of torpedoes, and in reference to that part of the line at which he is to fire the torpedo that is to shatter her. This is accomplishable by various methods; the choice of which must depend upon the condition of coast, &c., of the direction, in fact, in which the view of the line of torpedoes can be commanded. Thus if the attendant officer must look *along* the line, and that his post of observation is not elevated very much above its horizon, the line must be buoyed at equal intervals; and as the ship must pass between some two of these, or over one, he can discern by his telescope where in the line she is passing, and fire accordingly. This is of all others, however, the least certain mode. Suppose, however, that the post of observation on shore is somewhere about the middle of the line of torpedoes, but off on shore a good way perpendicular to the same. Now, if a good telescope be in succession adjusted to points only a few yards apart along the whole line, the changes of azimuth angle can be noted, and the same points afterwards found or observed in relation to those angles. Thus a theodolite becomes the means of fixing instantly the point along the line of torpedoes, over which a ship is observed through its telescope to be passing. For example, let the centre of the line be in azimuth = 0°, and a certain point to the right or left along the line be that at which the azimuth, as given by the telescope, is = 20°, or 25°, or 40°, &c.; and if the number of the torpedoes corresponding to those be known and marked on the contact maker, all that the officer has to do, when he sees the ship, is to observe the horizontal angle, refer to the corresponding numbers, press the button, and he fires the torpedo nearest to the ship.

There is still the source of error that, in this case, the one observer cannot be sure whether the ship be actually on the line, or a little to his side, or a little beyond it. This may be removed by the observer's position being chosen *oblique* to the line of torpedoes, and at a sufficient elevation above the line; or it may be met by two observers in electrical communication, one looking along the line, and the other transverse to it.

There is some little liability to delay, or to ill observation of precise position, here so indispensable, in all these cases; but still the system even now, if as skilfully carried out as it admits of, becomes one of the most powerful means of defence known for harbours, &c. The system of shore firing is not necessarily interrupted by the darkness of night; for it is obvious that the flash of the electric reflector may be kept constantly traversing the line of torpedoes. All these methods, and the instruments for use in them, are exhibited by Austria.

Austria also shows a good deal of her arsenal machinery, where it is presumed to possess some claims to originality or other merits. Spoke-forming and rifling machines for small arms are shown; excellent in their way, but not very peculiar. A machine for the proof of sword blades, on reception into store, is, however, of some merit, and has an immense advantage over the rude methods still in use of trial by the hand. The blade, screwed by its haft into a frame, is submitted with a perfectly known and adjustable velocity to a certain number of strokes at the mid length of its edge against a block of beech wood. It is also submitted mechanically to a slanting or glancing blow, at a given angle and velocity, against the side of a cylinder of hard wood; is bent suddenly, and suddenly released within fixed but adjustable limits for proof of elastic temper; and as to edge, is projected with a known velocity a certain number of times against a blunt edge of given breadth of wrought iron, which it must bear without being gapped. The sword blade of the Austrian service of all arms is slightly curved, and does not seem quite as well suited for fatally "giving point" as the perfectly straight blade. The sabres of the heavy cavalry are very heavy in the blade; and if capable of being handled with ease and the requisite velocity from the *wrist*, indicate that the Austrian troopers must be men of great power of arm.

Another direction totally diverse from any of those of which we have been treating, in which electricity has come to the aid of military science, is in the means which it has given to the artillerist of measuring the velocity of cannon shot in flight, and even of measuring the law of its increase of velocity within the chase of the gun, from the first moment when it starts, and is = 0, to its maximum in the gun, and its decrement afterwards, from the instant it leaves the muzzle and commences its free flight in air; throughout which also its velocity, and the

rate of decay of that, can now be measured with an exactness truly marvellous.

Gunnery began to be a science and a branch of mechanics in the hands of Tartaglia and Galileo; but these men, nor those that came long after them, never thought of measuring the velocity of a cannon shot, nor the resistance of the air with a given shot due to its velocity.

To the Quaker Englishman Robins, and to Dr. Hutton, were due those two great experimental advances in the first instance. Robins lived in pre-electrical days, or pre-galvanic ones at all events; and to measure the velocity of a shot at all, he was obliged to have recourse to indirect methods. He employed the ballistic pendulum; that is to say, a block of lead suspended firmly as a pendulum had the projectile shot into it, and brought to rest in its mass, which was known, as well as that of the shot. By the blow the pendulous block was struck up through a certain arc which was noted, and then the velocity of the shot was had from the formula, which as at present employed is

$$v = \frac{\sqrt{(\mathrm{P\,D\,K} + bi^2)\,(\mathrm{P\,D} + bi)\,g}}{bi}\ 2 \sin \tfrac{1}{2}\alpha.^*$$

This was done by Robins in 1740, but the block was rapidly deformed by firing at it; and so in 1780 Rumford proposed to suspend the gun as a pendulum, and to make its recoil, as measured by the arc, a measure of the velocity of the shot. This was for some time employed, and it is still employed in our own service as the method for proving the *relative* strength of powders. About 1840 or so, Wheatstone proposed his chronograph in connection with electricity; and it was soon seen that any instrument which could measure minute fractions of time correctly, and could be started and stopped by an electric current being made or broken, could be made available for the measurement of the velocity of cannon shot.

Several forms of chronograph were proposed in rapid succession; and about 1848 or 1849 Captain Navez, of the Belgian service (one which has given so much of science to the artillerist in latter years), produced his instrument, which, it is believed, was the first that was actually proved effective. The *Navez* instrument still depends upon the pendulum as the measure of time. It consists, in fact, of a graduated vertical arc, in front of which a short pendulum hangs. This is held up against a stop by an electro-magnet, and remains so until the current is broken; it then falls through a certain arc carrying a free moving index needle along with it, which latter is arrested the moment the current is re-established, the pendulum falling freely back to the vertical. We have thus the arc through which the pendulum has passed; and as we know its length, we know the time that corresponds to this arc. If, therefore, we fire the shot through two screens, or nets of wire work so constructed, that cutting the wires in its flight as the shot passes through the point and so breaking contact, it shall, by cutting the wires of the second, do the reverse—viz., restore the current—we have all the conditions necessary to enable us to determine the time during which the shot was passing through the space between the first and the second screens, and as this space is known, so to get the velocity.

Great an advance as this was, it did not reach the goal of perfection. There are some constant and some variable and indeterminate errors in the instrument, which, though marvellously accurate, is yet not enough so when questions of 3 or 4 feet per second in velocities of 2000 are concerned. As long ago as 1854, before a Navez was known in England, Wheatstone and Mallet together measured the initial velocity, or rather that at the earlier part of the trajectory, of the 36-inch shells of the latter, when fired at Plumstead, by means of the chronograph of Wheatstone as then improved by him, and executed under his direction by the delicate hand of Strohe. In these cases the instrument was released by the rupture of a conducting wire stretched across the mouth of the mortar. This was the method also employed by Vignotti, who produced a simplification of the Navez machine, and added to it a beautiful contrivance by which an electric shock struck a hole through a moving band of paper, at the instant that the shot passed through each screen.

Then about 1859 came the instrument of Major Benton, of the United States service, in which two pendulums and two batteries are employed, and which, whatever pretensions it may have had to greater accuracy, was certainly not a simplification on Navez. However, his *principle*, if we may so call it, of the two pendulums possessed some positive advantages; and Colonel Leurs, of the Belgian Artillery, applied it, and produced that form of the Navez instrument which has been recognized as an improvement, and goes by the name of the Leurs-Navez Instrument. This instrument is a little more complicated than Benton's, and liable to all the defects of the latter; amongst these, one of the most formidable is the liability of tremors communicated to the instrument to interfere with the free descent of the pendulum, another is the variability of the energy of the batteries. Any of these instruments, however, did well enough for roughly determining the velocity of a shot striking a target, or the like; but they all have this in common, that they can only determine the velocity of a shot at a single bit, one single space between two points, in its trajectory.

But gunnery now demands the determination of many other things, for which that won't do, even if exact. It demands the determination of initial velocity, not upon false data, as it was deduced from since the days of Bernoulli, viz., on the assumption that the whole of the powder is converted into gas before the shot stirs from its place in the gun—an assumption which, however, it is but justice to that great man to say he himself stated he did not think was true; but upon true data, which assigns the time during which the powder is burning into gas. It demands what effect upon this may be produced by varying the position of the vent in relation to the cartridge in the gun; what by heating the gun, &c.; and, finally, it demands *the law* of the varying velocity of the shot both in the chase of the gun and in the air outside it, and in the interior of resisting solid media of various materials, and so forth. For these ends we must have not only far greater exactness, but we must have the power of measuring the successive velocities of the shot from point to point, if desired, during its whole flight.

Two physicists have with great, though not rival, ability—for they have worked, we believe, in entire ignorance of each other's labours—made immense strides towards reaching this high aim; the one in England, the other in France. Professor Bashforth, of Woolwich, has produced his very admirable chronograph, of which a full account and detail of some of the results of its trials are to be found in the Proceedings of the Royal Artillery Institution, Woolwich, for the August of last year; a work replete with valuable papers by our own artillery and engineer officers, which are a credit to our service, or to any service, and a work which it is to be regretted is not more largely accessible. A copy is sent regularly to the Institution of Civil Engineers, London, and to each of twenty special honorary members. The Bashforth instrument consists of a barrel revolving uniformly by means of a clock, upon which two markers record—1, the time as traced by the clock; 2, the passage of the shot over measured distances in relation to that time. The instrument is not a cheap one, but cost ought to have no concern with instruments intended for such uses as the present; exactness here will always be the best economy, no matter what it costs. Two markers, under electric control, register by spiral lines in a permanent form upon the glazed paper fixed upon the revolving barrel, the time of flight (as fixed by the half-second clock), and the arrival of the shot at any number of screens or points in its flight. One pointer, starting off from the paper at each beat of the clock, marks the time by a momentary interruption of the spiral line; the other, by a like motion, marks the passage of the shot through each screen. The remaining sources of error are the variable time of movement of the barrel due to clock or pendulum errors, and the variable velocity of displacement and replacement of the markers, through variation in electro-magnetic intensity, with some others. The Bashforth instrument is exhibited formally, but we can scarcely say actually, and certainly most unworthily as respects its merits, being shown in a corner of the British Marine shed upon the Seine Quay. We are surprised that there is not more Woolwich *esprit du corps* to rescue it from its ill-deserved oblivion.

The other instrument, which certainly does appear to us to surpass in some respects the Bashforth, is that of Captain Schultz, of the French Artillery. It is carefully and well exhibited, and the mode of its application shown at a glance, in its proper place amongst the French Instruments of Precision in the main building. It was also exhibited at the memorable conversazione given to the jurors, &c., at the Conservatoire des Arts et Métiers, in Paris, about two months ago, upon which occasion the writer had the great advantage of having the instrument explained to him by Captain Schultz himself, and several circumstances as to its action discussed. A quite novel principle of minute time measuring is introduced here, and, so far as we know, for the first time in any chronometric instrument by any inventor. If a tuning fork

* See "Traité de Balistique," par General Didion. Second Edition. P. 332.

of steel or other highly elastic metal, of massive make, with parallel jaws, or a *diapason*, as the French call it, be caused to *sound* by a blow on one or both jaws of the fork, or having extended or compressed them by their sudden release, and the *pitch* of the note be determined by reference to an organ pipe or syrene, then the number of vibrations per second can be calculated. But as the same number of vibrations is made per second, by the nature of elastic vibrating bodies, whether the excursion of the points of the jaws be longer or shorter, so this number of vibrations per second becomes a true time measure, as true as any pendulum and truer than any clock, and of a far minuter fraction of time than any clock can note; for suppose the diapason vibrates 2000 times per second, one vibration or one double arc measures the $\frac{1}{2000}$ of a second in time, or the half vibration the half of this, or $\frac{1}{4000}$.

A polished brass barrel of some inches in diameter is so arranged that rotation and slow translation in the line of the axis of the cylinder are given to it by a clock, specially adapted to insure as much uniformity as possible, and also so arranged that the rate of revolution of the barrel may be varied in some multiple proportion. The surface of this barrel is blackened all over by the smoky flame of a lamp, so that a point traversing it with slight pressure will leave a trace. It is faced at one side by the diapason, standing vertically, and with the plane of its jaws parallel to the axis of the barrel. At either side of the jaws of the fork is placed an electro-magnet, so arranged as to release the fork, and cause it to commence vibrating, or to stop it at a required instant.

Now if, the diapason being at rest, the cylinder revolve, a marking point attached to one jaw of the former would mark a trace upon the blackened brass, a *circle* on the surface of the cylinder, and if the cylinder also move end on, a *spiral* curve; but if the diapason be vibrating, and the cylinder rotating, the trace will be a succession of *sinuous curves*, the length of each of which, along a circle or spiral traced on the cylinder, will be equal to the time of one vibration of the diapason, whether that length be longer or shorter, and the versed sine or sagitta of which, orthogonal to the last, will be equal to the vibratory excursion of the jaw of the diapason. The simple spiral first traced, thus becomes the abscis of all the sinuous curves traced along it afterwards. We thus mark upon the cylinder a set of curves, which, regarded from apex to apex, record equal and known intervals of time, and that, no matter whether the revolution of the barrel due to the clock be uniform or not so, though the clock may become a sort of control over the results, and is necessary otherwise. Also as the cylinder moves end on, this sinuous line of curves is a spiral one, and so may be continued indefinitely within the limits of length of the barrel. Furthermore, the *minute unit* of time with which we start at the diapason is capable again of subdivision upon the barrel; for suppose that the unit be as in the example above, $\frac{1}{2000}$ of a second, and that the *length of the curve circumferentially* traced at a given rate of revolution of the barrel be, say, 2 inches long, and that by an attached micrometer scale and microscope we can visually divide this length into 1000 parts, which would be only to observe $\frac{1}{500}$ of an inch—then we have got a measure of the $\frac{1}{1000}$ of $\frac{1}{2000}$ of one second in time, or of $\frac{1}{2000000}$ of a second.

Captain Schultz, in fact, finds that he can observe and register time to $\frac{1}{10000000}$ of a second. We have now only further to be able to register upon the same barrel, and close to the sinuous curve spiral, the instant in the time of flight that the projectile passes each of any number of successive points, whether in the air, or in the chase of the gun, or in the substance of a target. Let us see how this is done in air.

A number of screens of parallel wires (as in the Navez instrument nearly) are arranged in the line of trajectory, and at known distances from the gun and from each other. The galvanic arrangements are such that the current passes at first through the first screen only. At the instant this first screen is cut, and the current broken by the passage of the shot, a spark strikes from a metallic conductor upon the surface of the brass cylinder close to the sinuous curve line, and detaching from this in the form of a minute star, the lampblack leaves a distinct mark. That marks the moment of the passage of the shot through the first screen. At the same instant that the current is broken by the passage of the shot through the first screen, it is made or established through the second, and so on for the third, fourth, or any number of successive screens, a star mark being made upon the cylinder by the spark as the shot passes through each screen. We have now only to measure off into time by the micrometer the curves and intervals between the stars close to the same, to have all the elements necessary for determining the law of velocity of the projectile, and of the decadence of the same, and therefore of the resistance of the air to it in transit. So far for motion in air. But a far minuter problem remains for the instrument, viz., to determine the rate at which, from the instant of first ignition of the powder, the projectile in the chase of the gun starts into motion, and acquires rapidly a maximum either in the chase or just outside it, or which if the chase be extremely long may occur within it. For this purpose along one of the spiral grooves of a rifle gun (a bronze French service gun, for example) a number of holes are drilled and tapped at equal distances from the centre of the powder charge, and from each other. Into each of these is screwed a bronze plug, in the axis of which is drilled nearly through from the inside end a hole which is filled up with a cylindrical insulating plug of hard wood, having a copper conducting wire in its centre, which passes out through the outside of the plug without touching it. The plug of wood bearing against a shoulder in the drilled plug cannot be blown out. The copper wire is filed off square and left a little flush of the interior end of the wood plug.

The elongated rifled shot has a strip of zinc let into it on the side, and in the spiral direction facing the groove in the gun that has this line of plugs. When the shot is projected along the chase by the explosion, the zinc strip—the exact length of which is known—sweeps past and in metallic contact with the ends of all the copper plug wires in succession. The projectile and the body of the gun form one pole or terminal, the copper plug wires the other, of successive galvanic circuits, as before. When the forward end of the zinc strip touches the first copper wire, contact is made; and when the rear end of the strip parts company with same, contact is broken. The record is made by the chronographic instrument as before described, and thus we obtain the time that the known length of the shot has taken to sweep past the several equidistant plug points of the chase, and so get the law of its velocity. It is obvious that by slight variations in the arrangement we may register the time between plug and plug, as well as that between the forward and rear ends of the moving projectile.

Such is Captain Schultz' most elegant instrument. For some of the mechanical details he is no doubt indebted to the previous labours of M. König, the distinguished acoustic physical instrument maker of Paris. But the adaptation of the *diapason* to this purpose as an absolutely uniform and reliable measurer of small intervals of time, so as to be absolutely independent of any clockwork movement, is his own most felicitous invention. This, in fact, constitutes the distinguishing characteristic of the instrument, and places it at once immensely in advance of all other chronographic instruments applied to gunnery, including even that of Professor Bashforth, who has expressed himself fully alive to the inequality of rotative motion inevitable in all clockwork dependent upon an escapement and pendulum.

Throughout this article we have so far dealt only with what belongs to the offensive side of warfare, unless torpedoes may be viewed as of the defensive only. There are large displays, however, by Great Britain, and by several other nations, of armour plates, and armour and iron-clads, and divers plans of iron casemates and turrets, and other defences. Amongst all the armour plates shown, it is not without noteworthiness that the British plates are the most thoroughly perforated. Is this that our guns are more powerful than those of other nations? or that the iron of our armour plates is less good or suitable?

Amongst them all, so far as we can see, the Chalmers system of building up the backing holds its own as the best; and we believe experiments made at Vincennes during this Exhibition have demonstrated its value to the French government also.

We must, however, reserve the defence side of warlike implements and some other of the war material shown in the Champ de Mars to another occasion.—Ed.

PUMPING IN DEEP MINES.

Throughout the mining districts there are numerous instances where valuable minerals are lying untouched, simply on account of the difficulty of getting rid of the water in the surrounding strata. In some places the water fills into the shaft so fast that it has been impossible to put down a pump at sufficient depth to keep the water down. In certain cases numerous devices have been applied to prevent its accumulation, by sinking shafts or cutting drains at a lower level of the surrounding country. The cost, however, for executing and maintaining such works is in general so high that but little profit can be calculated off the

minerals when they are won; thus in numerous instances many of our most valuable mineral deposits are left untouched. There is a notable pit in Scotland where £30,000 has been spent in endeavouring to reach the minerals and keep out the water; we believe that the lessee of the field has at last abandoned his project. In such cases it is apparent

Fig. 1.

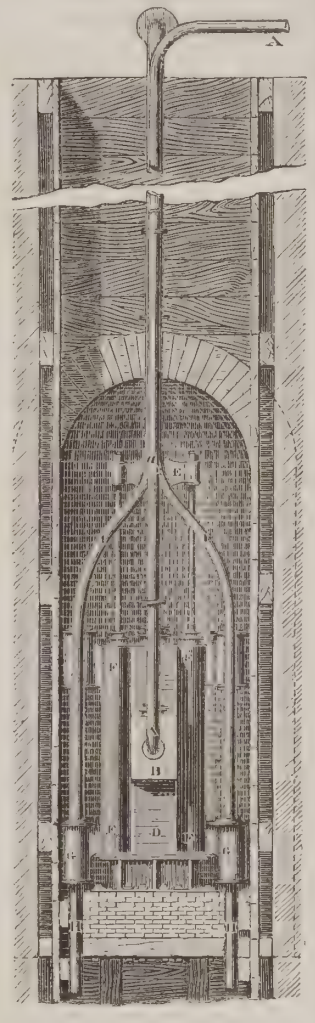
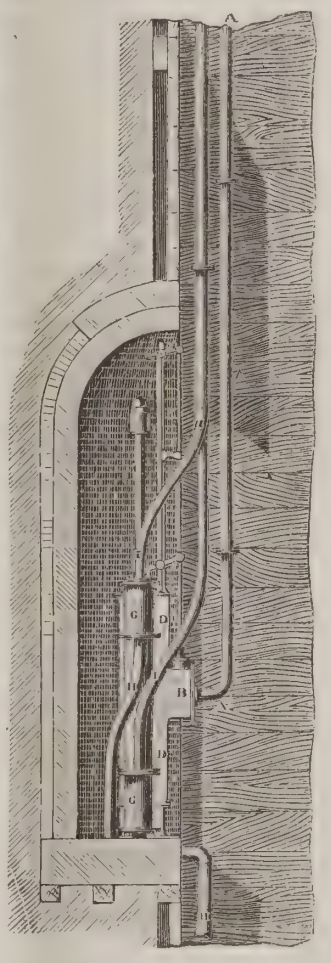
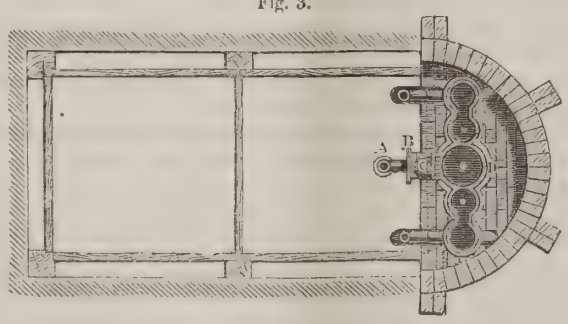


Fig. 2.



enough, that however large the pumping power supplied above ground, still the useful effect of that power is limited to the capacity of the pump that can be got into the shaft, leaving, of course, sufficient room around it to enable the sinking to go on. When, however, the water gathers so fast, the sinking can only be effected in dry weather often, at the

Fig. 3.



probable result of a wet season following, not unfrequently undoing or destroying the whole of a summer's operations.

To meet such cases as we have cited, a civil engineer in Glasgow has recently devised a pump which can be worked without any pump rods in the pit, so that there is practically no limit as to the size of pump that can be put down; capacity for pumping being supplied by length of stroke, instead of large diameter of cylinders. In using this pump for keeping down the water in the case of sinking a new shaft, it is placed on a timber platform, which floats on the water, and as the latter sinks, the pump becomes "self-lowering," by sinking with the water. The annexed views represent the pumping apparatus as fixed into a shaft, as it is sunk and bratticed.

The engine above ground is employed to compress air into a receiver, up to any pressure required; and the compressed air is led from this receiver by a pipe, A, to the valve chest, B, whence it is distributed alternately on both sides of the piston attached to the rod, C, and thus the piston is worked upwards and downwards in the central cylinder, D. The piston rod, C, is provided with a cross-head, E, to which the pump rods, one on either side of the piston rod, are coupled, and are thereby worked in the pump barrels, F. Beyond the pump barrels are the valve boxes, G. The pumps are double-acting. From the lower sides of the valve boxes, G, the pipes, H, descend into the water, and it is forced above ground through the pipes, I, which all unite into one pipe at the point, *a*.

Fig. 3 shows a horizontal section of the shaft, and the position, as well as the pump and valve boxes, also in horizontal section. When the pumping apparatus is being sunk, the compressed air and water are conveyed by flexible pipes, but after the necessary depth is reached metallic pipes are fixed in the shaft.—V. D.

ON SOME POINTS OF PRACTICE IN IRON FOUNDING.

No. XX.

(*Continued from page* 172.)

RESEARCHES ON THE BEST MODE OF CASTING THE RODMAN GUNS.

After the experiments which we have detailed, it may naturally be supposed that the American artillerists instituted inquiries as to the mode of casting which would give the best result. These researches are complete, and are remarkable for the method by which they have been conducted. We shall give a succinct account of them; and, first, as to the

Influence of the Time of Continuance of the Metal in Fusion.—It is known that the resistance of gray cast iron increases when it is re-melted in a reverberatory furnace. The same effect is produced by keeping the iron for a long time in a state of fusion. In order to judge how much the strength is increased by these processes, the Americans have made a number of experiments, some of which we shall describe.

Metal composed of four parts of Amenia iron and one part of Copake* was kept fused in the furnace for several hours. At the end of each hour a quantity of iron was taken out with a ladle, and a bar poured for proof. These bars were then tested with regard to density and tensile strength, and gave the following results:—

TABLE IV.

Amenia Iron, 4 *Parts*. *Copake Iron*, 1 *Part*.

Number of the Fusion.	Interval between Complete Fusion and the Successive Pourings.	Proof Bars Cast from Hour to Hour.	
		Density.	Tensile Strength.
	H. M.		
2nd Fusion,	0 15	7·175	20,336
	1 15	7·202	25,684
	2 15	7·216	27,456
	3 15	7·229	28,736
	4 15	7·240	29,227
3rd Fusion,	4 45	7·281	33,423
	5 45	7·288	30,644
	6 45	7·327	36,312
	7 45	7·343	37,552

This table shows a perfectly regular increase of density in relation to the time during which the iron remained in fusion in the furnace, and a general increase of tensile strength. This latter was finally 1·85 greater than at first.

Influence of successive Fusions.—The following table shows the gradual alteration of the original pig iron from the effect of successive fusions. The numbers 1, 2, and 3 refer to different colours of fracture.

* Amenia and Copake are, we need scarcely say, names of smelting works, as also Fishkill, Greenwood, and Kent.

No. 1 was the grayest iron.
No. 2 was the medium iron.
No. 3 was the brightest iron.

At each new melting the metal was kept liquid in the cupola for two or three hours.

TABLE V.

Greenwood Iron.

No. of Fusion.	Proof Bars.		
	Density.	Tensile Strength.	Hardness.
No. 1 Iron.			
In pigs, or 1st fusion, . .	7·032	15,129	8·48
" 2nd " . .	7·086	21,344	12·16
" 3rd " . .	7·198	30,107	19·66
" 4th " . .	7·301	35,786	29 52
No. 2 Iron.			
In pigs, ...	7·153	27,153	13·86
No. 3 Iron.			
In pigs, ...	7·230	34,923	21·40

The figures of the fourth column indicating the hardness of the metal were obtained by measuring the impression produced by a steel point under a fixed pressure. The point was terminated by a pyramid with sharp edges 0·10 inch high, and having a lozenge-shaped base, the diagonals of which measured respectively 0·10 and 0·20 inch. This point was placed on a polished plane surface of the iron, and a constant pressure of 10,000 lbs. was applied, and the length of the cavity produced was measured. If it be admitted that the hardness is inversely proportional to the volume of the cavity produced or to the cube of l, and if the hardness corresponding to $l = 10$ be represented by the volume of the entire pyramid = 3·333, the general expression for the hardness will be

$$\frac{10^3}{l^3}\,3{\cdot}333 = \frac{3333}{l^3}$$

The table shows that in the case of Metal No. 1, in successive fusions the density, strength, and hardness increased simultaneously. The density increased by 0·3, the strength increased to nearly double, and the hardness was threefold. The figures relating to Nos. 2 and 3 were added to the table to show that No. 1 approximated to them by successive meltings.

Influence of Mixtures.—By mixing different samples of iron in certain proportions, superior kinds may be produced; this is shown in the following table, where the different mixtures are classed according to the density of the product. All the iron embraced in this table came from the same cupola and the same ores as those in the preceding.

TABLE VI.

Greenwood Iron.

No. of the Mixture.	Charge in the Furnace.	Proof Bars.			Bars Cut from the Gaits.		
		Density.	Tensile Strength.	Hardness.	Density.	Tensile Strength.	Hardness.
1	No. 1 pigs, ...	7·086	21,344	12·16	—	—	—
2	1 part of No. 1 pigs, ... " No. 2 "	7·170	27,588	16·41	—	—	—
3	No. 1, second melting, . . .	7·198	30,107	19·66	7·090	25,716	12·82
4	3 parts No. 1 pigs, ... " No. 2 " . . . . 2 " No. 3 "	7·251	37,789	23·89	—	—	—
5	10 parts No. 1, second melting, 4 " No. 3 pigs, ...	7·259	36,916	28·62	7·169	28,910	17·62
6	8 parts No. 1, second melting, 6 " No. 3 pigs, ...	7·270	39,373	29·52	7·221	29,751	19·54
7	1 part No. 1, second melting, " No. 2, " .	7·272	40,897	26·67	7·228	32,421	19·50
8	No. 1, third melting, ...	7·301	35,786	29·52	7·257	33,815	21·88
9	3 parts No. 1, second melting, " No. 2, " . 2 " No. 3, " .	7·340	32,458	30·51	7·260	38,093	24·20

From some of these mixtures cannon were cast at the same time as the proof bars, and other bars were cut from the gaits of these castings, which were similarly experimented on. The three last columns of the table refer to these latter bars. Columns 3, 4, and 5 of the table show, 1st, That by adding gray iron to other brighter sorts, the density is increased, as well as by successive fusions. 2nd, That the tensile strength increased with the density as far as mixture No. 7, having a density of 7·272, and diminished with greater densities. 3rd, That, with almost a single exception, the hardness increased with the density even past the limit where the tenacity attained its maximum.

The three last columns show, 1st, That the density, tenacity, and hardness are uniformly less in the gaits than in the proof bars cast from the same iron. 2nd, That the density, tenacity, and hardness of the gaits increased regularly with those of the proof bars. 3rd, That the tenacity of the gaits did not attain its maximum in the same time as that of the proof bars (mixture No. 7), but that it continued to increase in the subsequent mixtures; so that in opposition to the rule given above, the tenacity of mixture No. 9 was greater in the bars taken from the gaits than in the test bars, although the density and hardness were less in the former than in the latter. 4th, That the greatest density of the gaits, = 7·260, is less than the density corresponding to the maximum tenacity of the test bars (7·272); but it is probable that if the metal had remained longer in the cupola, or that it had been submitted to a fresh fusion, the density of the gait would have become greater and greater, and would have reached a limit corresponding to the maximum tenacity, as in the case of the proof bars.*

The experiments made at Pittsburg in 1851, on the occasion of casting the 8-inch and 10-inch Columbiads, confirm the latter hypothesis, at least so far as concerns the increase of density of the gaits.

The results of these experiments are drawn up in the following table:—

TABLE VII.

Greenwood Iron.

Columbiads.	Bars cut from the gaits.		Cupola charge.
	Density.	Tenacity.	
8-inch, No. 3,	7·289	36,891	3 parts No. 1, 2 parts No. 2 — $\frac{3}{4}$ at second melting.
	7·295	39,031	
8-inch, No. 4,	7·281	43,650	3 parts No. 3 — $\frac{1}{4}$ at third melting.
	7·290	36,090	
10-inch, No. 5,	7·273	40,457	
10-inch, No. 6,	7·296	40,997	3 parts No. 1 — $\frac{1}{9}$ at first melting.
	7·306	42,425	2 parts No. 2 — $\frac{8}{9}$ at second melting.
	7·304	44,917	3 parts No. 3 — $\frac{3}{9}$ at third melting.
	7·304	45,970	
			Duration of fusion up to the moment of pouring = $2\frac{1}{2}$ hours.

The mixture of different iron for the 8-inch Columbiads approximates pretty near to No. 9 of Table VI., except that it contained one-fourth of whiter iron of the third melting. The metal obtained was more tenacious. The mixture of iron for the 10-inch Columbiads was still whiter, for it contained one-third of the three times melted iron; and accordingly the metal showed itself more dense and tenacious than the preceding.

In these experiments the maximum density was reached at the same time as the maximum tenacity, except in the cases of densities 7·306 and 7·281. But the first differs so little from 7·304, that the difference may be neglected, and the second may be considered as an anomaly which should not weaken the general rule. A tenacity of 45,970 lbs. per square inch is the greatest that has been found for cast iron in the course of the American experiments. As to the density 7·304, which corresponds to this tenacity, it differs sensibly from 7·272, corresponding to the maximum density of the test bars. but the latter maximum varies with the different kinds of iron; thus in the case of a mixture of four parts Amenia and one part Copake (Table IV.), the maximum resistance of the test bars corresponds to a density of 7·343.

Tables VI. and VII. show that new samples of iron may be con-

* At first sight, the existence of a limit beyond which the tenacity of the iron diminishes with an increase of density appeared not proved. In fact, this limit is indicated by the first series of Table VI. only (columns 3 and 4). It is not confirmed either by the second series of the same table (columns 6 and 7), nor by Tables IV., V., and VII., where we see almost constantly the tenacity increase with the density. It is only after having attentively read the chapter treating of *internal tensions* that Colonel Gadolin became confirmed in opinion; from which, however, we ourselves, in many respects, find grounds for qualification.

siderably improved by adding iron which has been melted two or three times. All the different kinds of iron had come from the same smelting cupola and had been obtained by the same processes. The opinion of the foremen founders was, that the employment of a mixture of iron coming from different smelting works and different ores would produce a still greater improvement. During the stay at Philadelphia of the American officers, they visited a foundry for the manufacture of railway wheels, and saw that the cupola was charged with fourteen different kinds of iron. Yet in some experiments made at Boston, mixtures of iron coming from different cupolas gave less satisfactory results than those composed of iron of the same origin. This at least is the result of the following Table:—

TABLE VIII.

No. of the Mixture.	Nature of the Pieces.	Number of Pieces of which the Means have been given.	Cupola Charge.	Bars cut from the Gaits.		Mean Duration of Fusion.
				Mean Density.	Mean Tenacity.	
1	24-pr. cannon.	20	Amenia; Equal parts of second and third meltings,	7·297	30,828	3·30
2	24-pr. howitzer.	15	Amenia and Fishkill in equal parts; of which 5 of the former and 2 of the latter were of second melting, .	7·217	29,583	3·
3	"	51	Amenia, 4 parts, Copake, 1 part; all of second melting,	7·247	32,306	9·
4	"	3	Amenia, 4 parts, Copake, 1 part; equal parts of second and third meltings, . . .	7·202	27,793	10·
5	"	35	Amenia; equal parts of second and third meltings,	7·305	36,651	6·
6	"	27	Amenia; 3 parts of second and 1 of third melting, .	7·316	35,294	3·30
7	"	3	Amenia; 3 parts of second and 3 of third fusion; Kent, No. 2, of first fusion 2 parts, ...	7·313	32,345	3·

This table shows at first sight that the best results were obtained with mixtures of iron of the same origin. Still it is not conclusive that a mixture of irons coming from different smeltings might not be advantageous, for it is possible that the samples added to the Amenia iron (mixtures 2, 3, 4, and 7) were inferior to it. Besides, the influence of the duration and numbers of fusions has not been studied in an exhaustive manner. Thus in mixture No. 2, composed in great part of once melted iron, the fusion did not last on an average more than three hours, but it is probable that if the iron had been kept longer in the furnace the results would have been better.*

The results given by the mixtures 6 and 7 were considered in America as a proof that the quality of the iron cannot be judged of by the tenacity of the pigs. The Kent pigs had a tenacity of 24,349, and a density of 7·315, while the tenacity of the Amenia iron of the first melting was only 14,140, with a density of 7·071. But mixture No. 6, containing no Kent iron, gave a tenacity of 35,294, and mixture No. 7, containing Kent iron, only gave a tenacity of 32,245, which shows that the addition of the Kent iron injured instead of improving the quality of the product. But we must remark that the Kent iron was the No. 2, and consequently was less susceptible of improvement by successive fusions than the Amenia No. 1, so that its original tenacity proves nothing in this case. However this may be, it is highly probable that different samples of No. 1 coming from different smelting cupolas, may improve very unequally by repeated meltings, and we doubt if the tenacity of the guns can be deduced from that of the pigs, for it may happen that one kind of pig of greater tenacity than another, may yet be less susceptible of improvement by a fresh fusion. The only real judgment which can be formed then of the strength of cast iron, is from the final tenacity which it acquires from repeated meltings.

Besides the influence of duration of time of the metal remaining in fusion, of successive or repeated fusions, and of mixture,* upon the tenacity of cast iron, there have been studied other circumstances of a nature to influence this resistance. These experiments have not led to any such positive results as those which we have just analyzed, because the experiments themselves have not been so numerous. Still the results are deserving of attention.

Influence of the Temperature of the Blast.—The influence of the temperature of the blast in the smelting furnaces is shown by the following experiment:—

TABLE IX.

Amenia No. 1 Pig Iron.

Temperature of the Blast.	Density.	Tenacity.
250°	6·948	11,420
200°	6·978	12,970
150°	6·967	12,243
Cold	7·071	14,140

It appears that the density and tenacity of the iron increase as the temperature of the blast is less. It is to be regretted that no trial was made whether cold blast iron was not also capable of improving by prolonged fusion.

Influence of Temperature on the Melted Iron.—The influence of temperature on the metal at the moment of pouring is shown in Table X. This table shows the transverse strength of three pair of bars cast in the following manner:—A sufficient quantity of iron for the six bars was put in a ladle and the first pair was poured immediately; the iron was then allowed to cool, and after a certain interval the second pair was poured; the iron was then allowed to cool still further, and the third pair was cast. One bar of each pair was cast in a dry sand, and the other in a green or moist sand mould. The cooling of the first was consequently less rapid than that of the latter.

TABLE X.

Temperature of the Iron at the Moment of Pouring.	Transverse Strength.	
	Dry Moulds.	Green Sand Moulds.
Highest,	8,176	9,726
Medium,	8,081	8,201
Lowest,	8,353	6,991

This table shows—1st, That the temperature of the iron has much less influence when casting in dry than in green sand moulds. 2nd, That in dry sand moulds the strength appears to increase slightly with the diminution of temperature, while it decreases considerably, on the other hand, in green sand moulds. The bars had a section of 2 square inches, and the distance between the points of support in the experiments on the transverse strength was 20 inches. The numbers of the table show the weight in lbs. capable of rupturing an inch cube of the same metal, fixed invariably by one of its faces to a fixed support, and the force acting on the opposite side. Calling w the force which produced rupture in a bar, l the distance between the two supports, b and d the width and depth of the bar, the number in the table is shown by the formula

$$\frac{lw}{4bd^2}$$

At the commencement of the experiments, and before the machine for experimenting on the longitudinal resistance was constructed, several trials were made of the transverse strength of different kinds of iron This mode of experiment is easy and the arrangements may be always made, but it is much less certain than the trial by longitudinal traction, and admits many more sources of error, although in the end the results may be the same. It is therefore a source of regret that the experiments relative to the influence of temperature on cast iron were not repeated with the machine for longitudinal traction.

(To be continued.)

* Such are Colonel Gadolin's views, in which, however, as well as in those expressed by the commission of American officers, whose experiments and conclusions he records, we can by no means ourselves place implicit reliance. A vast deal of what is here elaborately worked out (and in so far valuably), is merely going over again the old ground beaten by Mr. Fairbairn before, and with just the same confusion of thought as to first principles. The whole thing has been elucidated in one of our previous papers on iron founding. The graphite gets burnt out by prolonged or by repeated melting, that is all.—Ed.

PARIS EXHIBITION.

THE BOCHUM COMPANY.

LAST month we gave some account of Krupp's works at Essen, and of his exhibits at Paris. We now give some particulars of another gigantic iron and steel manufacturing company of note on the Continent, who have sent some work to the Exhibition very full of interest to the iron and steel trade.

The Bochum Company started in 1854 on the foundation of a former private company. The works are at Bochum, in Westphalia, and therefore like Krupp's are Prussian. The principal workshops are those devoted to the manufacture of—1, railway wheels, of which they produce on an average 400 pairs a month; 2, axles, turning out 1000 a month; 3, wheel tyres, producing 1000 a month; 4, springs, making 1500 carriage springs a month, and 5000 spiral springs; and 5, rails, of which they make 3750 per month. There is, besides, a cannon factory, consisting of a forge with six large steam hammers, with turning and finishing shops. They make, or are prepared to make, cannon of all calibres, as well as large shafts for marine engines. All their articles are made of crucible steel, except rails, which they make of Bessemer metal. The coke required for their foundries the Company make themselves at an establishment near Bochum. They have also iron works at two places (one on the Eifel, near the Rhine), where they produce about 440 tons of iron a month. At all these establishments they employ about 2500 hands, and their manufacture of steel amounts to 8500 tons a year, representing a value of £275,000. They have forty-four prime movers, varying in power from 10 to 380 horses. Their crucible steel furnaces are 113 in number, five being of a very large size; and their Bessemer converting vessels consist of two with a capacity of 80 cwt. each, and two with a capacity of about one-third of the others.

The Company's exhibits consist principally of bells, axles, railway springs, railway wheel tyres, railway wheels, the cylinders of an hydraulic press, and a locomotive-engine cylinder and steam chest (cast in one piece), all of crucible cast steel, and a Bessemer steel rail 49 feet long. Of the bells we shall speak on another occasion, and confine ourselves now to an account of their other exhibits, amongst which we must not omit to mention a steam-engine beam weighing 5952 lbs., and six locomotive and tender axles.

The first attempts to employ cast steel for railway axles were made in 1850. It was important in the first place to ascertain whether hard steel or soft steel was the better suited for the purpose. It was soon found by experiment that the latter quality of steel was much superior to the other, and it is only this kind which is employed at Bochum. Locomotive axles ought to possess two distinct properties: stiffness and tenacity. It is easy to obtain steel possessing one or other of these properties, but the difficulty is to combine them both in a sufficiently high degree. If an axle is wanted very hard, that is, with a high degree of elasticity, it ought to be made of hard steel; but such an axle would be soon broken, because the metal would not be able to resist sudden shocks; whilst, on the other hand, an axle of soft steel, although it would remain bent under a much less weight, would be able to resist a violent shock much better. It is to be remarked that, contrary to an opinion very generally entertained, axles of soft steel are more difficult to make, and are more expensive than those made of hard steel.

The following is a method of ascertaining the power of axles of cast steel to resist violent shocks. An axle of, say, 4⅓ inches diameter is laid across two cast-iron supports, separated by an interval of about 3 feet. A hammer weighing 1490 lbs. is allowed to fall upon it from the height of 1, 2, and 4 metres. The fall is then increased until the hammer has an elevation of 11½ metres (38 feet), and after each blow the axle is turned a quarter round. It is not usual for the axle to break until after several blows of the hammer falling from the height last mentioned, an excellent proof of the extraordinary tenacity of these cast-steel axles. Axles of this structure are so much in favour on the Continent on account of their many advantages, especially on lines with steep gradients, that the Bochum Company have manufactured more than 40,000 for railway carriages, and several thousands more for locomotives. They say they have never succeeded in overcoming the difficulties which present themselves in the making of axles from Bessemer steel, and they more than hint that these difficulties are in their opinion insuperable. They consequently employ crucible steel, which they assert is superior in quality and homogeneity, whilst there can be no doubt that the less combination of phosphorus with crucible steel, will render the axles much less "cold short" than Bessemer steel axles can be.

The Company exhibit specimens of their cast-steel carriage springs, and they state that they have turned out 150,000 of such springs for German railway companies. They, moreover, state that their arrangements are such that they can make, in case of need, 100 carriage springs and 150 buffer springs *daily*. They also show fourteen tyres of from 1 to 3 inches in thickness; one of them has been twisted to show the tenacity of the metal. In order to avoid the imperfections of a welded wheel, they invented the plan of forging an ingot of cast steel into an elongated shape, and then, after splitting it along the middle, extending it into a ring. The Bochum Company adopted at first another method; they cast the metal in the form of a ring, but of a diameter less than half the size intended. Its thickness was of course much greater than the final thickness required. It was then rolled, by which process it was at once enlarged and reduced in thickness to the desired extent. At present they proceed in a different way: they cast twenty or thirty tyres at once in a single piece; that is to say, they form a long hollow cylinder, having a diameter of about one-third of the tyre required. This is cut into several rings, which are enlarged by hammering and rolling. One of the Bochum exhibits is a casting, weighing 22,000 lbs., of twenty-two wheels, with their tyres, all in one piece, that is to say, the tyres are all in one piece with the body of the wheel, certainly a very questionable mode of construction. The Bochum rolling machinery is driven by an engine of 300 horse-power. It is generally admitted that cast-steel tyres possess many advantages over iron or puddled steel tyres. In the first place, the metal itself possesses much greater tenacity, and then the liability to break at a weld is avoided. Another advantage is, that the wear is at once less and more uniform; and this latter fact is attended with the consequence that, when it becomes necessary to send them to the lathe, the loss of material is less. Besides, since such tyres preserve their circular shape much longer, the carriages to which they are applied are less shaken, and therefore last longer. These advantages being so clear, it is not surprising that the Prussian government has directed all the passenger carriages on the railways belonging to the state to be furnished with them. The Bochum Company has made about 40,000 of these cast-steel tyres for German, Russian, Swiss, and French railways.

Steel tyres have, however, this inconvenience, that they are liable to break; and hence many engineers prefer wheels and tyres cast in one piece. This at least appears to be the opinion on the continent; however, speaking from several years personal practice with steel tyres, we have found them much less liable to fracture than the iron ones formerly used. With iron, split tyres were of almost weekly occurrence, with steel we found fractures an exception. At Bochum they are cast of the size referred, and do not afterwards undergo any hammering or rolling. After annealing, they are merely submitted to the lathe and the boring machine. In 1860 a series of experiments were conducted by a committee of German engineers, who unanimously came to the conclusion that the Bochum wheels were the most solid and the strongest then known. The advantages claimed for wheels of this description are, that they raise less dust, and consequently that the bearings last longer; that their circularity is maintained longer than wheels with separate tyres, which have always a tendency to become polygonal; and that the dangers flowing from the rupture of tyres, the giving way of bolts, rivets, &c., are wholly obviated. It has also to be considered that, when the rim of such a wheel is worn out, the wheel may still be made to serve as a disc upon which a tyre may be fitted. The Bochum Company state that their wheels may be run 55,000 miles before it is necessary to send them to the lathe. They have manufactured 20,000 of these wheels, chiefly for German railways, and they exhibit as specimens two pairs of carriage wheels, and one pair of driving wheels; the latter having a diameter of 5 feet 7⅞ inches. These wheels, though costing more at first, are cheaper in the end than wheels of the ordinary construction. The charge for a cast-steel axle with two cast-steel wheels, finished and fitted to the axle, the whole weighing nearly 1720 lbs., is about £30; and this may be 20 per cent. higher than the usual charge in Germany for a pair of iron wheels with puddled-steel tyres and a cast-steel axle. But if we may trust to the certificates given by some engineers in charge of German railways, the Bochum wheels are at least three times as durable as wheels with tyres of German puddled steel. It was proved that, for a wear of

one-sixteenth of an inch, the Bochum wheels ran 39,248 kilometres, wheels with tyres of German puddled steel 12,000 kilometres, and wheels with tyres of English iron only 10,500 kilometres.

The Company exhibit the cylinder of an hydraulic press. This is of steel run into sand. Since the tenacity of steel is at least four or five times greater than that of cast iron, a pressure proportionably greater may be maintained; so that the ram need only be half the diameter of one of cast iron. In order to diminish the deterioration of the interior of cylinders, it had become usual to line them with steel; but this was attended with the inconvenience that, if the lining was fractured—and fractures are not unusual—the cylinder was rendered useless. By the Bochum plan of casting the whole in one piece, the strength of a cylinder is increased, without there being any corresponding disadvantage.

Cast-steel cannon are claimed to have originated, in Germany at least, at the Bochum Works. In 1847, before Krupp, of Essen, had directed his attention to the subject, Herr Mayer, the present head of the Bochum establishment, cast a steel muzzle-loading cannon at Bochum. Although that specimen was much superior to cannon of ordinary structure, the manufacture was not very actively prosecuted; and Krupp, by advancing from improvement to improvement, got the business almost completely into his hands. The Bochum Company now state that they have lately gone to great expense in fitting up a cannon foundry, with boring machines, &c., and that they are prepared to manufacture cannon of every size and description. One of their acquisitions for the purpose in view is a 60-ton hammer. We may remark the Company had intended to exhibit the models of two rifled breech-loaders of cast steel, but that at the request of the Prussian government they were not sent.

With regard to rails, it is well known that those of steel are far more durable than iron ones. The expense of crucible steel rails, however, is such that they cannot find a market; and under these circumstances, the Bochum Company have had recourse to Bessemer steel, which experience has shown to answer remarkably well, whilst they are much cheaper than rails of crucible steel. Their only exhibit under this head is the rail 49 feet long already mentioned.

Finally, we may allude to the specimens of bars exposed in a case to show the fracture, and which prove that the Bochum metal is at least equal to the best in the Exhibition.

THE PARIS EXHIBITION.

NOTICES OF SOME SPECIALLY INTERESTING OBJECTS, &c.

ROCHE-TOLAY'S TUNNELLING APPARATUS.

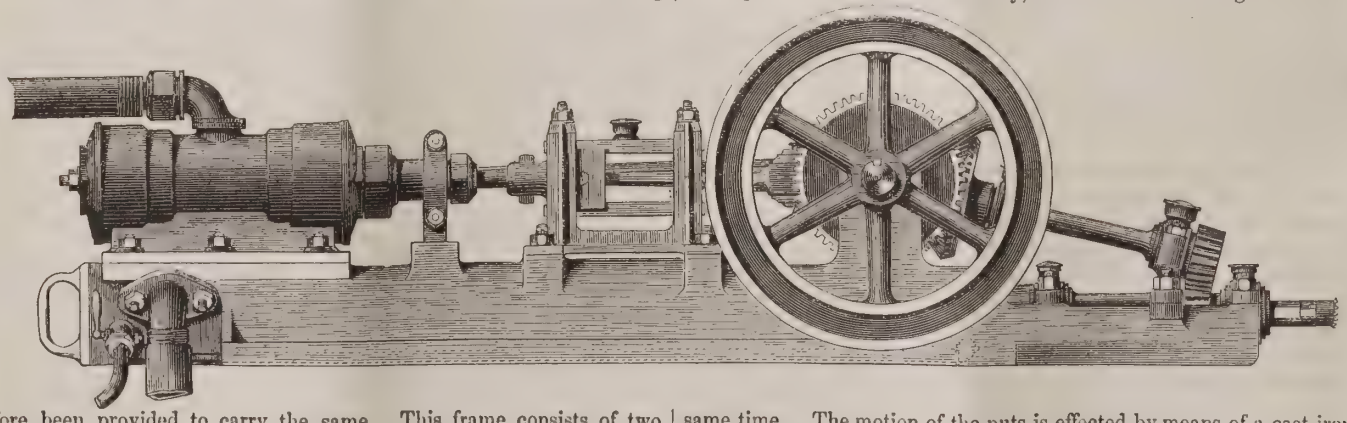
THIS apparatus, of which a working model may be seen in the machinery gallery, class 47, is specially adapted for boring the adits in mines, and for tunnelling through rocks. The apparatus, of which we illustrate a side elevation, consists of—1st, A direct-acting boring machine, with continuous rotatory motion, provided with a water-pressure engine: 2nd, A frame to carry several machines for tunnelling operations.

The boring machine is composed of a hollow hexagonal shaft of cast steel. One end of this shaft is arranged for the reception of tools of various forms, according to the nature of the rock to be bored. The Leschot ring, provided with a crown of black diamond points, or a drill with a certain number of pieces of hard material set on one of its bases, or steel augers or cutters of various forms for soft stones and metals, may be employed. The other end of the shaft carries a brass piston, on which the pressure acts for the propulsion of the boring tool, such pressure being obtained by a water fall, or by force pump, with an accumulator and air reservoir. The pressure in the machine may vary from 0 to 12 atmospheres, which gives a pressure on the boring tool of about 22 cwt., whilst a pressure of about 14 cwt. is sufficient to perforate the hardest rock. The water which serves to operate the piston is conveyed by a small india-rubber tube, carrying at one end a two-way cock.

In order to withdraw the perforating tube or shaft when a hole is bored, the supply of water to the propelling cylinder is stopped by means of a two-way cock, and the water is directed on to the face of the piston; and as the cylinder is emptied at the same time, the return of the shaft is effected with the greatest facility. The shaft is mounted in a brass frame, bored true and smooth for a certain length, in which the propelling piston may move. By this apparatus holes may be bored from 35 inches to 39 inches in depth, and of a diameter of from $1\frac{3}{8}$ inch to $2\frac{3}{8}$ inches. The shaft carrying the drill traverses an iron socket between two bushes disposed in front of the frame, which socket is provided with a small bevel wheel, receiving motion from an inclined shaft, through the intermedium of a brass wheel keyed on to the driving shaft.

The engine consists of a horizontal brass cylinder, which is bolted on to the frame in which the shaft is mounted, and carries at its top part an elbow pipe, connected with an india-rubber tube intended to convey the water which actuates the piston. In this cylinder there is disposed a brass tube, or "regulator," which is accurately bored and turned, and is perforated with holes at its ends, and receives a to and fro motion from an eccentric, made in one piece with the driving shaft. The "regulator" is maintained in its place in the axis of the cylinder by means of two boxes provided with brass segments pressed by springs, and these segments also prevent the admission of water round the regulator during its longitudinal motion. A leather-packed piston works in the interior of the regulator, and on its two faces the water alternately exerts its pressure, the stroke or reciprocating traverse is $4\frac{3}{8}$ inches, and this motion is converted into a continuous rotatory motion by a crank and connecting rod. The water, after exerting its pressure on the piston, escapes through two pipes disposed at the back and on each side of the driving cylinder. A pair of fly wheels are provided to insure regularity of motion.

In the excavating operations of tunnelling several boring machines are required to work simultaneously, and a frame or carriage has there-



fore been provided to carry the same. This frame consists of two cheeks of sheet iron and T irons, maintained at a proper distance apart by cross-pieces fixed at the top and bottom, the whole being supported by two pairs of wheels which rest on rails. Each cheek carries at its fore part two vertical screws, on which work four nuts, which support in couples iron cross bars, so that the latter are capable of ascending or descending the length of the screw, and are maintained parallel at the same time. The motion of the nuts is effected by means of a cast-iron socket enveloping the cross bars, and carrying a bevel wheel at each end, which gears with a corresponding bevel wheel on the nuts, so that by simply turning the socket by the aid of a lever the cross bar may be elevated to any convenient height. On each of the cross bars there is a cast-iron frame, which frames carry at their back part two bars attached to the uprights of the carriage by a cap and bolt, and to the

frame itself by a socket and a couple of nuts. The two cross bars are independent of each other, so that each frame may be elevated or depressed separately; and the frames are also capable of an angular motion around the cross bar to the extent of about 40°. Each frame is constructed to carry four boring machines, which are fixed thereon by four screw cramps, so as to admit of adjusting them to the most suitable angle for boring. The water is conducted to the cylinder through india-rubber pipes, and its admission is regulated by eight cocks attached to one of the arms of the frame of the machine. Other pipes are provided to carry away the water discharged from the cylinder.

An air reservoir is also provided at the back part of the machine frame, for the purpose of diminishing the shocks to which the pipes would be subjected by any variation in the velocity of the water. This reservoir is formed in the middle of a cast-iron tube, which is connected by india-rubber piping with the main conduit for the introduction of the water under pressure at the back part of the frame. The india-rubber pipe thus admits of the carriage being moved either backwards or forwards for a few yards without its being necessary to alter the length of the main pipe. The carriage is firmly secured to the machines by four screws, of which the two end ones serve to give a perpendicular appearance to the frame.

Experiments made with a machine using the ring-boring tool of the Leschot system show that with an expenditure of 75 litres of water, at a pressure of 8 atmospheres, which gives 100 turns of the boring tool, the following results are effected in distance bored:—

	Per minute. Inches.
In mica schists (a tunnel on the Port Vendres line), where there is but little quartz,	$1\frac{3}{16}$
Do., where there are thick veins of quartz,	$\frac{3}{8}$ to $\frac{5}{8}$
In pure quartz, from the excavation at the Mont Cenis tunnel,	$\frac{1}{2}\frac{1}{16}$
In dolomitique limestone, of a very hard nature, susceptible of polish, from the Cantegals tunnel on the Rodez and Montpellier line,	$\frac{3}{4}$

With a pressure of 8 atmospheres the machine may be worked at 250 turns per minute, with the following results in distance bored:—

	Per minute. Inches.
In the mica schists (Port Vendres tunnel), where there is little quartz,	3
Do., where there are thick veins of compact quartz,	1 to $1\frac{3}{8}\frac{1}{16}$
In pure quartz, perfectly regular, from the Mont Cenis tunnel,	$1\frac{3}{8}$
In very hard dolomitique limestone (Cantegals tunnel),	2

The result of the experiments which have been hitherto made give grounds for the belief that, by the use of this apparatus, a saving of 15 per cent. will be effected where the water has to be artificially elevated, but that when the water does not require to be raised the saving will be at least 40 per cent.

TURBINES.

M. Jean Larger, of Felleringen, exhibits two turbines of the respective diameters of 39 inches and 6 inches, the former being intended for high falls.

We translate the following description of M. Larger's improved turbines from the *Genie Industrielle*.

His improvements have reference to—1st, The form and relative proportions of the float boards of the wheel or *receiver* proper, as well as of the directrixes or the adductors which feed them. 2nd, The arrangement of the pivot of the vertical shaft, and of the step, and the lubrication of the principal parts. These improvements are applicable to centrifugal as well as to overshot turbines.

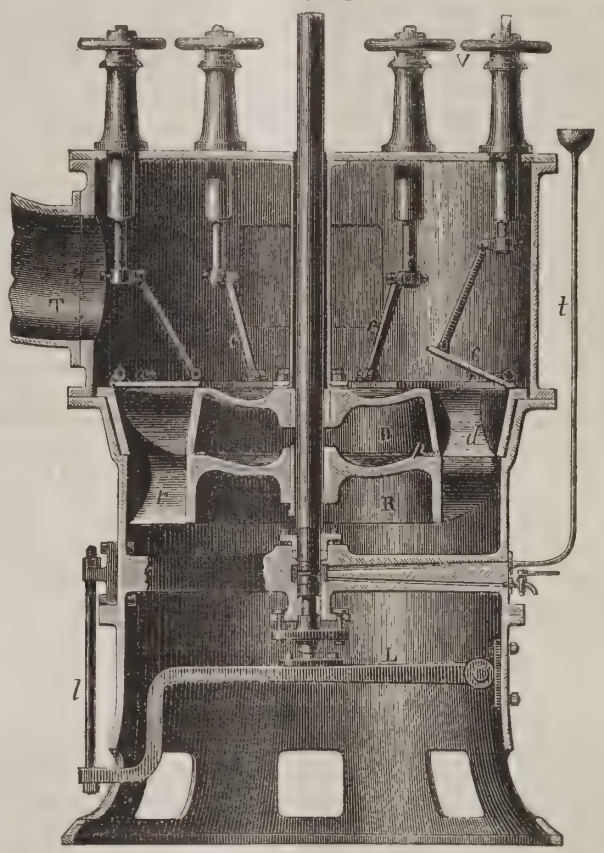
With regard to turbines on the centrifugal system, these are usually provided with cylindrical float-boards of the curvature shown at A (fig. 2); the first element, *a b*, of the float-board which receives the water proceeding from the adductors, *c d*, being made nearly at right angles with the tangent, *a*, at the circumference of the wheel, so as to be very nearly perpendicular with the latter by corresponding, if prolonged to its radius.

M. Larger at the outset made the float-boards of the curvature shown in B, so that the first element, *a′ b′*, makes an angle of from 45° to 50° with the radius, *a′*, and is, as it were, a prolongation of the end of the directrix, *c′ d′*, which conducts the water to it without any shock. This first modification caused a sensible improvement in the results, as it admitted of the wheel being worked at a lower speed, by which a better effect is obtained. M. Larger also arranged that the total section of the apertures of the turbine should only exceed that of the apertures of the distributor in the proportion of the velocity of the water admitted to that of the external circumference of the wheel. Thus when for a given fall the arrival velocity of the water on the distributor is 10 metres per second, and consequently that of the turbine 6 metres, the sections are arranged in the inverse proportion of 6 to 10.

But there is an advantage in reducing the section of the apertures of the wheel, more especially when a scarcity of water necessitates the closing of a part of the apertures. Thus, with a low fall of from 2 to 3 metres feeding a turbine having vertical escapement, and with three-fourths of the apertures closed, an effect is obtained nearly proportional to the quantity of water expended.

In carrying out his experiments, M. Larger has adopted for centrifugal turbines with a large fall, the arrangement shown at C, which arrangement has the advantage of obviating that species of eddy or disturbance which the water produces in the larger space between the

Fig. 1.



float-boards after its admission. It consists in an additional part, *l m n*, which forms a check to the eddy or disturbance. Its enlarged curvature is such that without being exactly parallel to the internal curve of the float-board, it gradually and continually tends thereto as it approaches the external circumference, so that the section at the exit is somewhat smaller than at the inlet. The result of this addition is that an increased duty of nearly 25 per cent. has been obtained on that of the modified wheel, B, when in good working order, and which had already far exceeded in amount of work the first wheel, A.

In the overshot turbines, such as Jonval's (shown in fig. 1), M. Larger's modifications have produced the most satisfactory results. He at first endeavoured to prevent the loss of water which takes place between the wheel and the distributor, either through imperfect fitting or by the wear of the pivot and step, by attaching or casting unto the wheel, R, a ring, *p*, which is accurately turned as well as the corresponding flange of the distributor, D, by which means all play between the two surfaces is prevented, except that which is absolutely necessary for the motion. When, in consequence of the wear of the pivot, the wheel descends a little, it may be adjusted by raising the central rod by means of the lever, L, and the vertical rod, *l*, by loosening the nut of the latter.

The pivot and its step pass through stuffing boxes which, while admitting of their sliding in a vertical direction, prevent any communication with the interior, so that the oil which fills the small chamber

formed around their surface of contact cannot escape. The oil is introduced through a tube, *t*, which is carried up to a convenient height and passes through the crosspiece cast with the frame on which the whole machine is mounted. When it is required to clean out the oil chamber a cock attached to the lower tube is opened, when a rod can be passed through to draw out all the grease.

Instead of causing the water to arrive on the float-boards at an angle of from 24° to 36°, as is generally the case, by which a great part of the column of water presses on the wheel, M. Larger so arranges it that the water arrives at an angle of from 14° to 15° at the most, as shown in figs. 3 and 4. For this purpose he slightly hollows out the end of the directrixes from *u* to *v* (fig. 4), instead of making them a straight line; the part removed does not affect the strength of the distributor.

Fig. 2.

For the same object the angle which the part, A *b*, of the float-board makes with the horizontal plane, A *e*, is reduced as much as possible, which admits of an increase in the curvature of the whole surface, A *b c m*, along which the water introduced glides, and consequently also in the curve, *n′ d*, which starting from the lowest point, advances gradually to *d*, so as to describe a line nearly parallel to that, *a′ b′ c′ m′*, of the adjacent float-board; in fact it only differs from it by the distance between them being slightly increased towards the top.

The pressure of water is also diminished on the back, *m d*, of the float-board, by making it an angle of 2° or 3° greater than the prolon-

Fig. 3. Fig. 4.

gation, *m m′*, of the directrix, that is to say, it makes an angle of 17° or 18° with the horizontal plane instead of 15°.

After these various modifications, which have undoubtedly effected considerable improvements in this class of hydraulic engines, M. Larger has been led to determine exactly the best proportions and forms for obtaining the greatest effect. Thus after fixing the diameter of the turbine according to the volume of water at disposal, and settling the depth of the currents of water which are to run off through the orifices of the distributor, he arranges that the space between each of the bars of the grating placed up the stream to prevent the passage of branches of trees, herbs, and other extraneous bodies, may be narrower than that between the directrixes measured at their lower part, and on their internal circumference. The height of the crown, *r*, of the turbine (fig. 1) is made about six times the depth of the current of water running out of the wheel; if, for example, the shortest distance between two consecutive orifices of the latter be 10 millimetres at the external circumference, its height will be $10 \times 6 = 60$ millimetres.

M. Larger has proved also that in order to obtain a good result, when the machine works so that the speed of its external circumference is from 0·66 to 0·75 that of the water, it is necessary to make the directrixes of the distributor at an inclination of 15°, that is to say, the directrix, *m m′*, of the lower element (fig. 4) with a horizontal plane should not exceed that angle. The line, *m* A, which indicates the direction of the float-boards, is at an angle of 60° with the line, *m m″*, and consequently an angle of 45° with the horizontal plane.

When the width of the crown is equal to one-third of its external radius, the angle measured on this internal cylinder should not exceed 75°, the corresponding angle on the external cylinder being 60°, so that it is always smaller than would be obtained were they arranged concentrically. Thus, A *m* being the inclination of the float-board at the larger radius (figs. 3 and 4), in order to determine the inclination, *y m*, of the same float-board at the smaller radius, the distance from A to *y* is so regulated that the difference, *e y*, relatively to the total length, *e* A, will be in the proportion of the velocities at the internal and external circumferences.

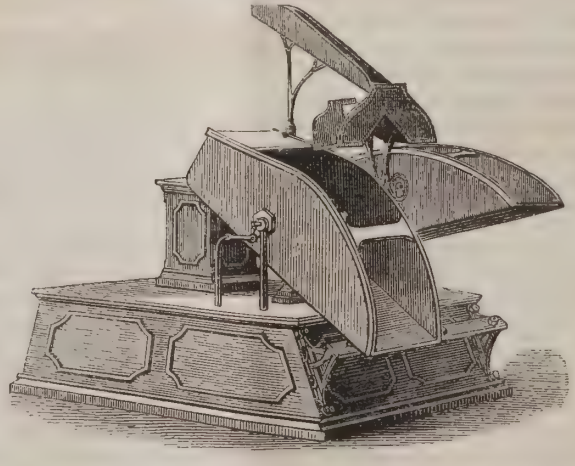
It only then remains to determine the curve, *y z u* (fig. 3), on the internal cylinder. For this purpose the curve, A *b c d* (fig. 4), is first formed so that it may agree as exactly as possible with the lower element, *b* A, and terminate at the summit, *m*; the point, *c*, will then necessarily be the farthest from the line, A *m*, and at about the middle or three-eighths of the height, *m c*, of the turbine. A perpendicular, *c f*, is then erected on the line A *m*, and another perpendicular, *f z* (fig. 3), equal to *c f*, on the corresponding line *u y*, the point *f′* being fixed at a proportional distance from the ends. By this means the water runs over a more decided curve on the internal cylinder than that of the external cylinder, which is favourable to the efficient working of the turbine.

M. Larger has often observed in ordinary turbines, that obstructions are formed by solid matters which enter therein and are unable to pass through, owing to the orifices of the wheel being smaller than those of the distributor. He obviates this defect by reversing this arrangement, and makes the wheel orifices larger than those of the distributor. When the water available is conveyed through an inclosed tank or reservoir above the distributor, the inventor makes the tube, T (fig. 1), which conducts the water to this receptacle at least six times the total size of the lower orifices of the distributors, and in that case he prefers to make these lower apertures of the same size as the upper.

We understand that twenty-four turbines on M. Larger's system are already at work, equal to an aggregate of more than 500 H.P.

AUTOMATIC GRAIN-WEIGHER.

Amongst an excellent display of weighing machines of all kinds by Messrs. Henry Pooley & Son, of Liverpool, we noticed a most ingenious



self-acting apparatus for weighing grain, which we illustrate. It consists of two oscillating or tipping buckets, so balanced on their centres as to tip over and discharge their contents the moment a determined weight of grain has been run into them. The grain to be weighed is directed into the two buckets alternately by means of a spout made to

vibrate laterally to and fro, and carried on an upright situate between the two buckets. From this spout the grain is directed on to one or the other side of a stationary ridge, situate exactly between the buckets, and discharging into one or both of such buckets, according as the grain is directed wholly on one side of the ridge, or partly on one side and partly on the other. Supposing both the buckets to be empty, and turned up ready to be filled, the supply spout will be so turned by mechanism within the stand acted upon by the buckets, as that it will discharge the grain wholly on one side of the ridge, and consequently one of the two buckets only will receive the grain. Just before the determined quantity or weight of grain has entered the bucket, the latter is caused to descend slightly, overcoming a weighted lever inside the stand; and this motion has the effect of diverting the spout almost entirely over the opposite side of the ridge, leaving, however, a small stream of grain to still fall into the nearly full bucket, whilst the empty one is being at the same time filled. So soon as the grain in the first bucket has attained the proper weight, the bucket tips over and discharges its contents, the same movement instantly turning the spout full over the opposite side of the ridge, so that the whole of the supply may be directed into the second bucket till it is nearly full, when the same diversion of the spout again occurs, and the now empty bucket is supplied, and so on, the operation of weighing going on continuously, and in a perfectly automatic manner.

TEN TONS RAMSBOTTOM PATENT DUPLEX HAMMER.

We noticed here the working model of a ten tons Ramsbottom patent duplex hammer.

The special use of the original ten tons duplex hammers (exactly reproduced in all its details by this model) is the forging of steel or iron guns; large shafts and crank axles; solid weldless tyres from solid ingots, punching the hole in the centre, and flanging the rim ready for rolling; and for performing the operation of cogging, or roughing down large ingots of steel or blooms of iron for rails, girders, plates, &c., &c. The improvement or superiority of this hammer over the vertical hammers is said to consist, firstly, in dispensing with massive and costly foundations; secondly, the working parts are not liable to get out of order; thirdly, less manual labour is required to manipulate the ingot or bloom, they being fixed in centres, and easily turned over to the faces of hammer. Another important advantage is that these hammers work without causing the injurious vibration produced by hammers of ordinary construction.

We understand that this hammer is used by the London and North Western Railway Company at their works at Crewe; by Messrs. C. Cammell & Co.; by the Barrow Hematite Steel Co.; the Ebbw Vale Steel and Iron Co., and others.

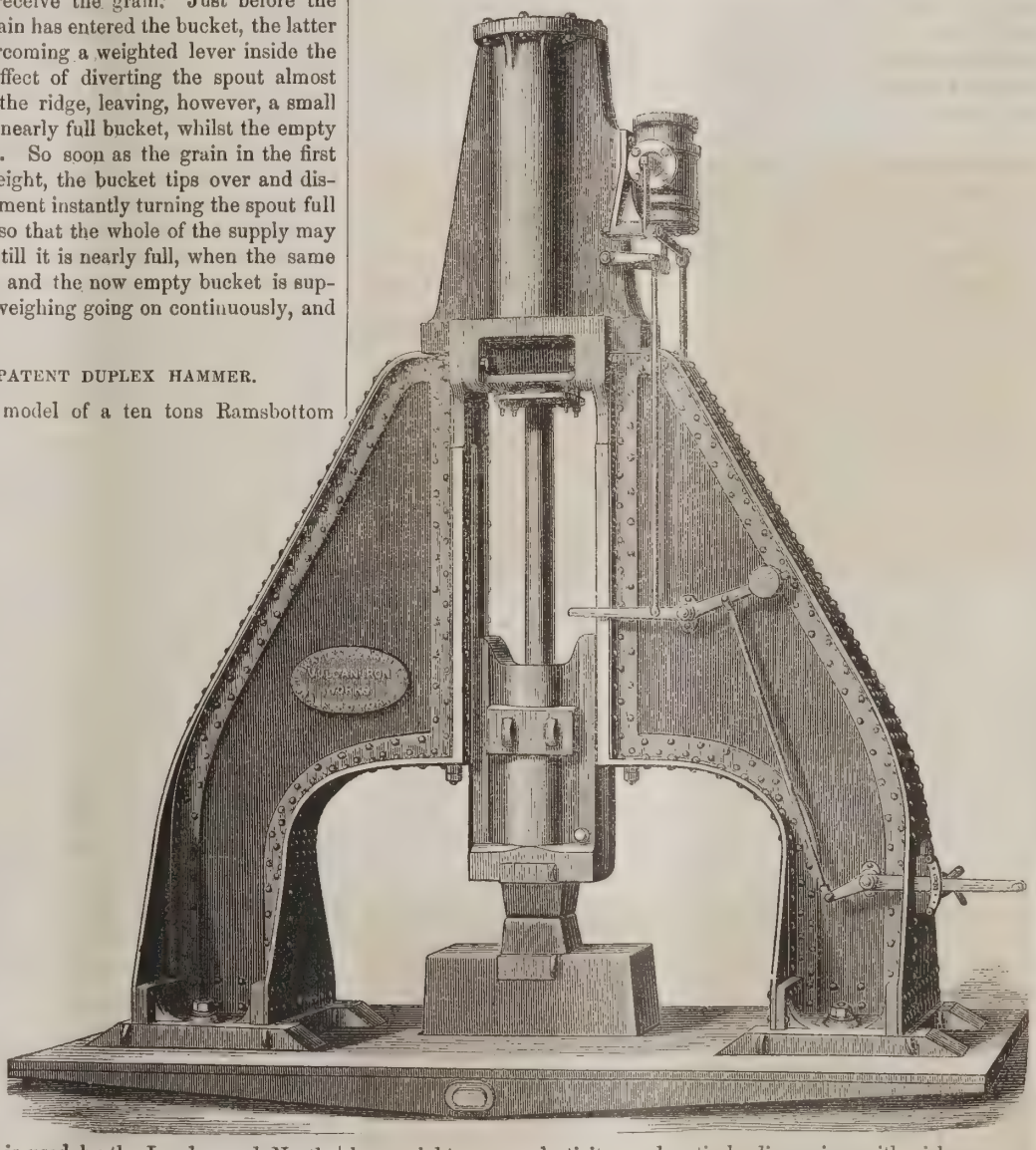
THIRTY TONS RAMSBOTTOM DUPLEX HAMMER.

A model of Ramsbottom's thirty tons duplex hammer is also exhibited by Messrs. Thwaites & Carbutt. It conveys a very correct idea of the original thirty tons hammer made by Messrs. Thwaites & Carbutt, and working very satisfactorily at the Crewe Works of the London and North Western Railway Co.

This hammer is very suitable for forgings of the heaviest description, and combines all the advantages enumerated in reference to the ten tons duplex hammer. This form of construction would be found very convenient in making hammers of a large class, say up to 100 tons, or even larger. The working heads can be made in two or more pieces; and the movement is gained by direct connection to two large steam cylinders, one at each end of the framing. The valves of both cylinders are worked simultaneously. The movement of the hammer heads is governed with a right and left hand screw, cut upon the same shaft on which works a nut fixed in each head, causing the screw to rotate alternately in contrary directions, thereby preventing any irregularity that might occur in the relative motions of the working heads.

THWAITES AND CARBUTT'S TWO TONS VERTICAL DOUBLE-ACTION STEAM HAMMER WITH MALLEABLE STANDARDS OR FRAMES.

In this hammer (see cut) wrought iron is substituted for cast iron in the standards or frames, giving increased strength, with considerably



less weight, more elasticity, and entirely dispensing with risk consequent upon producing large castings in one mass. With these advantages are coupled the convenience for exporting the frame in parts, and then rivetting them together on reaching their destination, all the parts being made in duplicate. Defective portions, moreover, can at any time be easily replaced; whereas in the case of cast-iron frames, a very slight fracture at once becomes fatal to the entire frame. Hammers of this class have been supplied to many of the largest steel and iron works of England. Messrs. J. Brown & Co., Sheffield, employ ten steam hammers of this description, varying from 6 to 15 tons weight of head respectively; also the Barrow Hematite Steel Co.; Messrs. Loyds, Fosters, & Co., Wednesbury; Henry Bessemer, steel works, Sheffield; and some others.

In manufacturing these frames each portion is made to template and gauges, and all the edges of the plates are planed and fitted together; the holes are all drilled, and care is taken that each hole comes exactly opposite a corresponding hole. Rivets are made to fit the holes, which are slightly countersunk on each side; consequently all the parts take their full share of strain. The cylinder and base for the same are cast

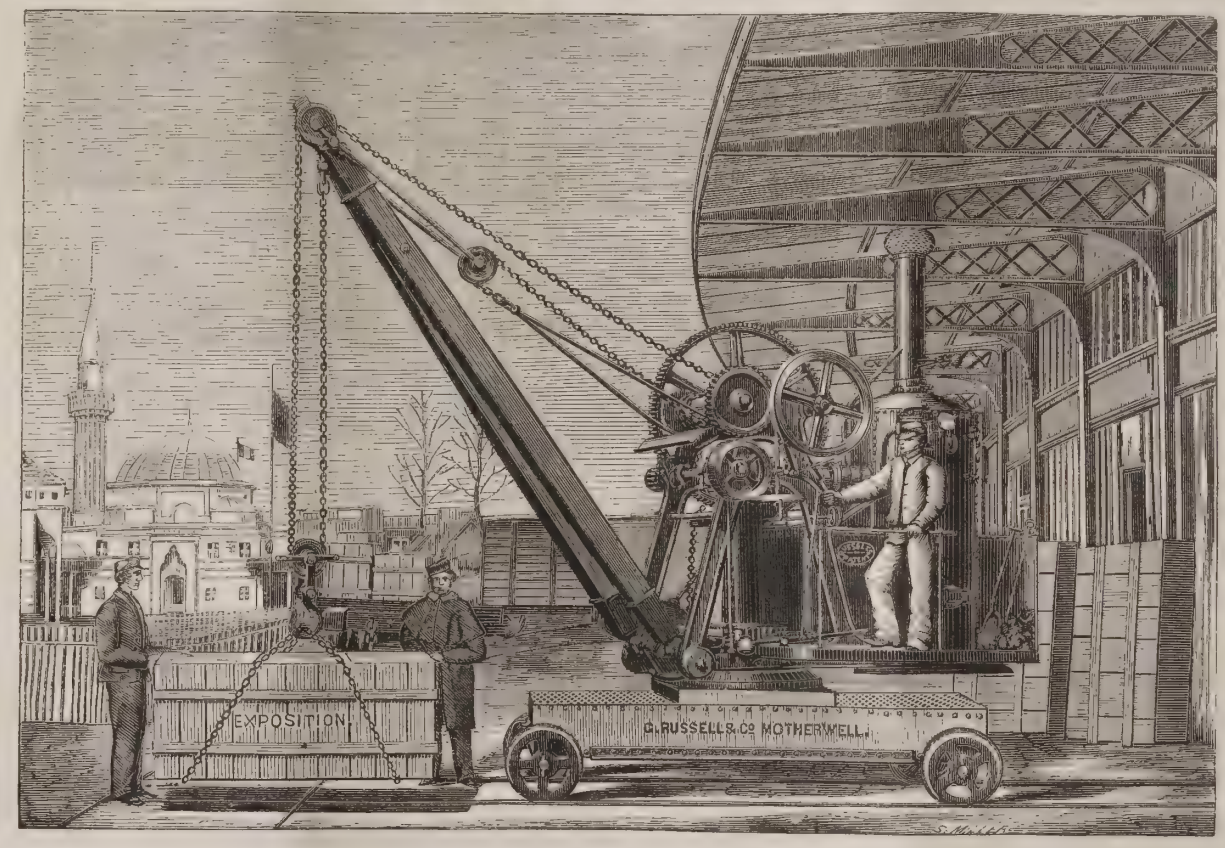
in one piece, and securely bolted on to the frames by through bolts, also by side bolts, which bind the frames together. This arrangement dispenses with the large joint at the bottom of cylinder, which is liable to constant leakage. The equilibrium or working valve and stop valve are fixed in one case, bolted to the face on the side of the cylinder, so as to be entirely out of the way of the cranes, whereby articles operated upon can be brought under the hammer on either side. The working valve is in equilibrium, and made of cast iron; it is of circular shape, easily replaced, simple, and effective. The piston and rod are forged solid of wrought iron, with a large boss or collar at the part fixed into the hammer head, and securely cottered on either side. The glands and bushes round the piston-rod at the bottom of the cylinder are made in halves of brass. Wrought-iron gland plates are also made in halves, so as to allow the rod to be withdrawn.

The special use of this hammer is the making of steel axles, or steel and wrought-iron general forgings.

STEAM CRANES AT THE PARIS EXHIBITION.

In the British Department six portable steam cranes are exhibited by different makers. This fact shows the growing tendency to employ steam power in preference to hand labour for hoisting purposes. Even so lately as at the date of the International Exhibition at London hand-worked cranes were used for a number of purposes for which steam cranes are now generally employed. For instance, a ship is not now considered complete unless she is furnished with steam winches or cranes for working the cargo; and the cranes on wharves are now rapidly being superseded by, or where practicable converted into, steam cranes. Contractors and builders also have generally adopted the steam crane, and the saving in time and working expenses, even on an average contract, is found to be considerable. We therefore consider the subject of sufficient importance to devote a short article to a review of the principal steam cranes in the Exhibition.

Near the Australian gilt pyramid at the principal entrance, the Porte Rapp, are four steam cranes, exhibited respectively by Messrs. George Russell & Co., Motherwell, near Glasgow; James Taylor & Co., Birkenhead; Appleby Brothers, London; and Alexander Shanks & Son, London. All these four cranes, in the general arrangement of the principal parts, are somewhat alike. Each is mounted on a carriage and wheels, and all the gearing and boiler are movable radially round a central pillar; the boiler being on the opposite side from the jib, assists to counterbalance the load. The crane exhibited by Messrs. George



Russell & Co. differs from all the others in various points. The engines are horizontal, which arrangement allows the cylinders to be placed close to the steam space of the boiler, and at the same time, leaves all the space between the boiler and central post free for the tank, which is consequently of a very large size. The door of the feed tank is held by a central bolt, so that whilst, on one hand, making a steam-tight joint, it can, on the other, be fixed in a few seconds. It is necessary for the door to be steam tight, as the water boils by the absorbed heat of the exhaust steam. The central post is of malleable iron, forged solid, and the carriage is also of malleable iron, with angle irons inside. The arrangement for the radial movement deserves notice. The power is communicated from the hoisting barrel shaft to a worm shaft near the bottom of the framing by means of an endless chain working in plain V-grooved pulleys, and this chain is adjusted so that sufficient power is conveyed to work the swinging mechanism; but if by some accident the jib, or any other part of the crane, should come in contact with any obstacle while swinging, the chain would slip on the pulleys, and the crane would thus cease to swing, while the engines continue in motion. This arrangement will save much breakage, it being a very frequent occurrence for steam cranes to be broken by an obstruction while swinging, because, although the power required for swinging is very small, the movement must be slow, thus giving the engines great leverage to cause breakage. The platform is large and placed at one side, where all the handles are conveniently arranged for the driver, who has a full and uninterrupted view of the load. The engines have link motions for reversing. The hoisting barrel shaft has brass bushes and malleable-iron covers; and a good feature in the general arrangement is that any one or all of the shafts can be removed without disturbing the framework, or other adjacent parts. The jib is of oak, in two pieces, spread out at the bottom, and joined in one socket at the top. Its radius is adjustable by a hand wheel and worm motion. This crane was used by the British Executive Commission in the installation of the machinery and goods during February and March, and worked remarkably well, without the least mishap of any description. We illustrate it from a photograph taken while it was at work.

The crane exhibited by Messrs. James Taylor & Co. differs from all

the others, particularly in the boiler. The boiler is of a form generally used for marine purposes, being horizontal, with return tubes over the firebox. The carriage and also the lower portion of the framework is of malleable plate iron. Besides hoisting and swinging by steam, it also adjusts the radius of the jib, and propels itself by means of gearing from the engines. This adds a considerable amount of gearing, especially the propelling movement, the power being conveyed by a vertical shaft working in the central post. The boiler is placed far from the post, so as to balance the load, being constructed to travel with the load suspended. The driver's platform is placed outside the framework, but all the handles are inside; they are, however, close together. The jib is constructed of plate and angle irons rivetted together; narrow at top and at the bottom, it is the full width between the side frames. The workmanship of the whole is excellent.

The crane exhibited by Messrs. Appleby differs from the others in having the carriage and conical race for supporting the jib of cast iron, in one piece. This is a much cheaper mode of construction than the other cranes. This crane has, like Messrs. Taylor's, gearing for propelling and adjusting the radius of the jib by steam. Its appearance and probably its efficiency is impaired by the prominence and length of the steam and exhaust pipes, which are of malleable iron, and rise vertically from the engines, and stretch over the driver's head to the boiler and funnel. The jib is of the same description as Messrs. Taylor's. The driver is placed between the engines and boiler, and the feed-water tank is hung on one side of the boiler. A small donkey engine is provided for feeding the boiler. Several of the intermediate shafts are fitted with bushes with adjustable covers, but the main barrel shaft runs in a simple bored hole in the frame, without any provision for taking up the wear. The side frames are ugly in outline.

The crane exhibited by Messrs. Shanks is nearly alike to one which was exhibited in 1862. It is inconveniently arranged for repairs, as one of the side frames must be removed before the shafts can be disconnected, and all the shafts except the engine shaft are without provision for adjusting the after wear. The platform is rather awkwardly placed behind the boiler, that is, on the opposite side of the boiler from the post, where the driver cannot have so clear a view as is necessary. The swinging motion is effected by a worm wheel fixed on the post gearing with a worm shaft, as in Russell's, but, of course, the worm shaft is geared in the usual way to the engines, by spur wheels; a double clutch serves both the hoisting and swinging movements, so that, unlike all the other cranes, the two motions cannot be used simultaneously. The engines are inverted, the cylinders being close to the top of the boiler, so that the steam connections are compact. The jib is of timber, similar to Russell's, as is also the gearing for adjusting the radius.

It will be observed from the short description of the leading points of these four cranes that they vary very much in details. The materials used for similar parts also vary; for example, the steam pipes in Messrs. Russell and Taylor's are copper, in Messrs. Appleby's of malleable iron, and in Messrs. Shanks' of cast iron. The hoisting motion of Messrs. Taylor & Appleby's has double purchase with single chain, and Messrs. Russell and Shanks have a simple wheel and pinion, and the purchase is again doubled by the use of a return block. The cranes of the former makers are necessarily much more complex than the latter, in having additional motions for adjusting the radius, and travelling by steam.

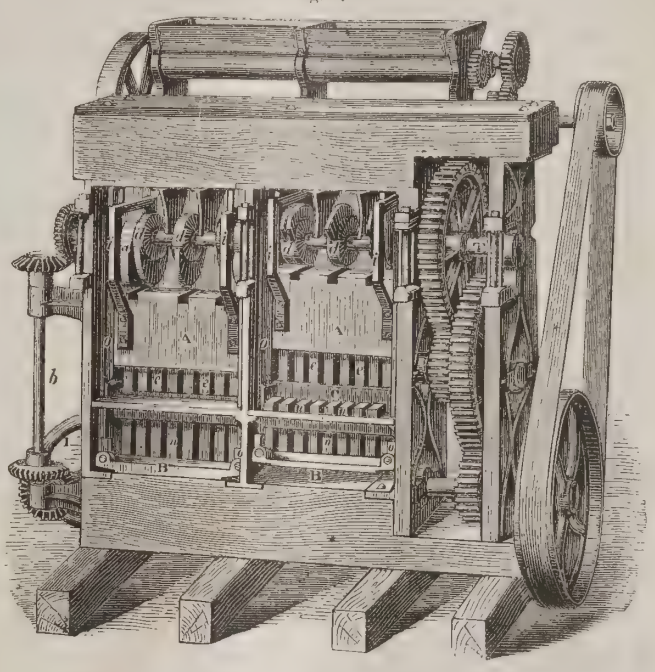
Messrs. Stothert & Pitt, Bath, have a steam crane in another part of the Exhibition, which is not equal to those we have described, either in design or workmanship. There is also a very small crane, with rotatory engines and complicated gearing, exhibited by Thomson, Edinburgh. Some other steam cranes are exhibited, amongst which we may mention that in the collection of the Compagnie Belge. This crane possesses certain peculiar features, and it has been constructed according to a design patented by M. Neustadt.

BRICK-MAKING MACHINERY.

THE art of brick-making is one of the most ancient; but how bricks were produced in old primeval times we have little knowledge, except that the descendants of the old patriarch found it difficult to "fashion them without straw."

In modern times in this art, as well as in nearly all others, attention has not been wanting in saving the human labour part of the process. Accordingly we find that more than twenty years ago the first brick-making machine worthy of being recognized was developed in America, and afterwards patented in this country; the patent being subsequently purchased by the late Mr. Samuel Platt, of Platt Brothers, Oldham, in whose hands the original Yankee machine was unsuccessful. Mr. Richardson, of Messrs. Platt Brothers, devoted his attention to improving and perfecting the machine, in which he succeeded. Nevertheless, brick machines have, up to the present time, been of very complicated nature, as witness that exhibited by the son of the inventor of the first machine we have alluded to, at present exhibited at Paris, although in

Fig. 1.



an odd corner by itself, and apart from the Exhibition and its park altogether; the unparalleled powers of which have nevertheless been boasted of on both sides of the Atlantic with a mighty complement of American blaze. After having ourselves made a personal examination of the machine in Paris recently, we can only say that as a piece of workmanship it is well executed, but as a machine of simple construction, good design, or of the best adaptation to its purpose, it is neither. It is indeed, as one writer has expressed himself, "a dazzle of complexity."

We believe that there is no reason why such a straightforward operation as the making of a brick is should not yet be performed by some of the simplest of means; and that such will yet be devised we have no doubt. The simplest and, as it appears to us, the cheapest, and therefore the best, machine yet devised has recently made its appearance in America. We take the following description of it partly from an American contemporary:—

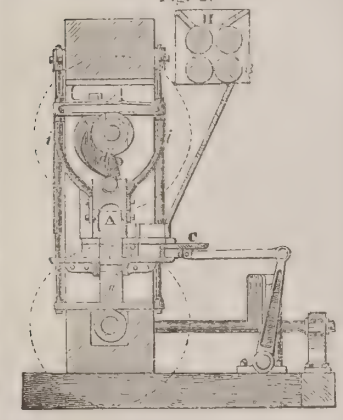
This machine is intended to make what are known as 'dry-pressed brick'—that is, to make bricks direct from the clay as it is dug from the bank, and to make them in immense numbers. The clay is first placed into a hopper, H, fig. 2, from whence it passes between a pair of heavy smooth iron rollers, B, one of which revolves faster than the other; from these it passes between a second set of rollers, placed still nearer together, effectually grinding every particle of the clay, and all gravel or small stones that may chance to be in it. From the rolls the clay drops on to a 'picker,' consisting of a toothed cylinder and concave, which pulverizes and lightens up the mass in a most thorough manner, after which it drops into a hopper, having a movable bottom or slide, C, working transversely through it as represented in fig. 2, this slide serving to fill the moulds with clay, lubricate the table and plungers, and remove the bricks as fast as made.

The machine consists of a very strong frame, the uprights being of cast iron, and all tied firmly together with iron rods; and in the lower portion of the frame, on a level with the bottom of the lower or receiving hopper, is placed a series of moulds open at top and bottom. The bottom of these moulds is filled by a series of followers, *n*, supported on the plate, B, this plate having a stirrup, O, at each end, which extends up and passes over a cam on the main shaft, T. Above the moulds is

a heavy pressing-block, A, provided with a series of plungers, *e*, which fit into the upper ends of the moulds; this block, A, being raised by a stirrup, *i*, at each end, passing over and being operated by a cam, *a*, on the same shaft, the blocks being pressed down by another pair of cams, *d*, working on friction rolls in the upper face of the block.

At the further rear corner of the machine is seen a cam-wheel, I, which imparts motion to the slide, C, that fills the moulds with clay, motion being transmitted from the main shaft, T, through the medium of the vertical shaft, *b*, and the bevel-gear, as represented. The operation is as follows:—When the machine is set in motion the plungers, *e*, being raised out of the moulds and held above them, the slide, C, with its compartment filled with the prepared clay, is pushed forward over the open moulds, the clay falling into and filling them. The slide is then drawn back into the hopper, where it receives a fresh charge, the plungers, *e*, descending as soon as it is out of the way, and compressing the clay in the moulds. As soon as the compression is accomplished, the plungers, *e*, are raised, the followers, *n*, raising at the same time and propelling the brick upwards out of the moulds, when the slide, C, coming forward to re-charge the moulds, pushes the brick thus made forward on to the table, a set of eight bricks, marked *u*, being shown thus pushed forward in the right-hand part of fig. 1. The machine is made double, there being eight moulds on each side, and one set being cleared while the bricks in the other set are being pressed. It is, however, obvious that they may be made of any desired size: the company manufacture three sizes, for making four, eight, and sixteen bricks.

Fig. 2.



This machine is said to be capable of producing 7500 *bricks per hour*. In Chicago, where one has been set up and put into operation, it is spoken of in the highest terms.

Apart altogether from the puffing it has naturally received from the character of the very nation in whose hands it has been produced, we feel bound to say that, so far as we can judge prior to seeing the machine at work, it promises in every respect to be a superior adaptation of mechanism to perform a hitherto handicraft operation.—V. D.

COIN AND COINING.

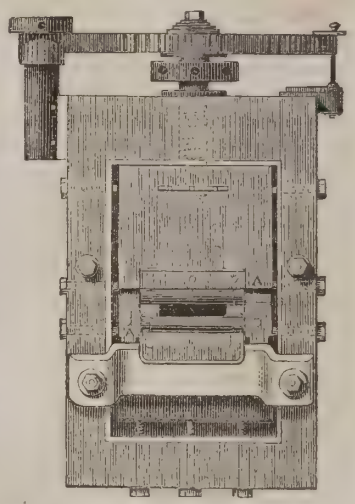
By J. Newton, Esq., Royal Mint.

(*Continued from page* 137.)

The gauged ribands are now placed upon an iron omnibus truck, and transferred to the adjusting or drag-room. This is a long and narrow apartment, having its tunnels or trenches and its subterranean shafting and wheels, though on a much smaller scale than those of the great rolling room, already described. Indeed it is a peculiarity of the machinery of the Mint that most of it is propelled by the agency of underground gearing. The truck-load of golden ribands, or straps, then, we will imagine to have been pushed on to this department—and were silver in course of working the same thing would happen—and while the work-people are preparing to deal with them, let us examine the mechanical and other arrangements of the place. What is known as the "flatting-mill" is the first on the list of machines in the adjusting room, and it consists of a pair of small steel rolls (only 4 inches in diameter) supported in a light and not inelegant frame of cast iron, firmly bolted down to girders spanning the trench below. The rolls are driven by comparatively miniature toothed wheels, which again are impelled by aid of pulleys and leather straps. The upper roll of the flatting-mill has the singular characteristic of having three portions of its surface at equidistant points of its circumference perfectly flat. The flat surfaces are of course longitudinal to the axis of the roll. The lower roll is, on the contrary, perfectly cylindrical. A vertical screw, a horizontal wheel of brass, a pinion of the same metal, an index and a lever, enable the workman to regulate and adjust the distance between the two rolls.

The use of the flatting-mill is simply to prepare the ribands for entrance into another machine, known as the draw-bench, and this it does by pinching the end of each riband. As the rolls slowly revolve the attendant advances the attenuated plates of gold (or silver) one after another to the mouth of the mill, and when a flat surface of the upper roll in its passage over the lower one permits of his doing so, he introduces a riband between the two. There it rests for a moment, and a moment only, for a circular part of the upper roll advancing by rotation, catches tightly the precious material and pushes it back, after pinching it severely, into the hands of the workman. Thus, in succession, the whole batch of ribands is treated, and thus they all become qualified candidates for the next machine in the series, known as the "draw-bench."

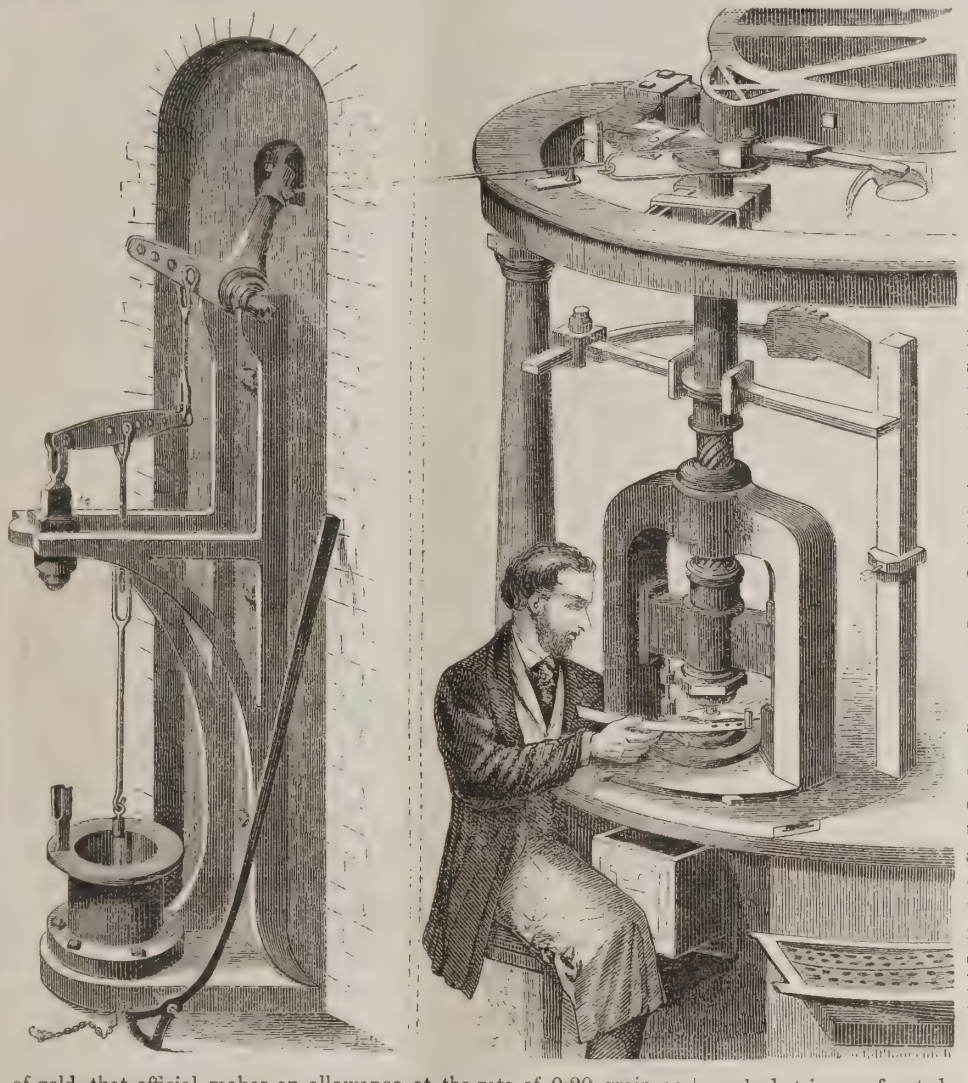
This apparatus is a clever, though palpable modification of a very old implement used for wire-drawing, and it answers tolerably well the purpose to which it is applied at the mint. That purpose is the equalization of the thickness of gold and silver straps or fillets to a much greater degree of exactitude than rolls can accomplish. The mint draw-bench consists of a long cast-iron frame or table, firmly secured to the floor of the room in which it is placed, and immediately over the shaft trench. Along the surface of the draw-bench pass endless pitch-chains, the links of which are of gun-metal, and the pins or pivots of steel. The driving-wheel for pulling the chain forward has projections on its circumference, which as they revolve catch the cross-pins of the chain alternately, and thus drag on the chain itself with irresistible force. The chain returns along the lower side of the draw-bench, and again emerging at its upper surface is ready to resume its duty. At the end of the bench opposite to that where the driving wheel rotates—that is to say, at a distance of 12 feet—is a massive case of iron, known as the "head of the draw-bench," and of this part of the whole contrivance the subjoined is an illustration.



Within this "head" two steel cylinders, one immediately above the other, are deposited. These rest on hollow beds supporting them throughout their whole length, and they do not rotate. By means of capstans and screws the space which separates the cylinders is governed. The cylinders are seen at A A in our engraving. If sovereign ribands are being dealt with, the cylinders are set at the sovereign distance; if florin ribands, a wider space is allowed, and so on for all other coins. Such are the main features of the draw-bench, and it will now be understood why the ribands have had their ends thinned at the flatting-mill. It was in order that they might pass between the adjusted steel cylinders to a sufficient distance to allow of their being bitten by the teeth of a mechanical dog, and then drawn by main force between the cylinders themselves. The 'dog' is readily engaged or disengaged from the travelling chain by the attendant, and when in action it pulls the ribands forcibly between the steel regulating dies until all inequalities in their thickness are got rid of and uniformity is arrived at; and thus it fares with all strips of gold intended for conversion into current coin. After this equalizing process has been performed satisfactorily, and it is a highly important one, the strips are cut into short lengths and "tried." The trials consist in punching out blank discs or planchets from each short strip, and weighing them, *seriatim*, in an apothecary's balance of extreme delicacy. Should the verdict of the judge, or "tryer," in the case be favourable, the strips are sent forward to have performed upon them the next operation. If the draw-bench has not achieved its mission to the very letter, the strips must travel once more between its cylinders, or else be relegated to the melting-house. It will be easily comprehended that metal intended for yielding sovereigns or half-sovereigns, which should be legally almost of uniform weight, must be of very equal consistency throughout. Without attention to the gaining of uniform thickness of the precious metals indeed in the coining of gold, coining would become a farce. The sole use of the draw-bench is to insure that uniformity of dimension which alone can

insure uniformity of weight. It is true that the law allows of certain infinitesimal differences in the weight of individual sovereigns, half-sovereigns, shillings, or sixpences, so as to meet imperfection of workmanship and variations in the density of the precious metals; but it is clear that mechanical agencies employed in coining must be carefully contrived if precise results are to be arrived at.

In testing the blanks cut singly by the tryer from the drawn strips of gold, that official makes an allowance at the rate of 0·20 grain on the pound weight, in order to cover the subsequent loss by annealing. Having proved by scrupulously exact weighments of trial-pieces that the strips of metal are worthy of preferment to the cutting-out room, they are advanced to that department accordingly. This room is very handsome. It is circular, and contains twelve punching presses, each of which may be adjusted for producing blanks of silver, gold, or bronze, of any denomination in either metal. The presses are arranged above a platform of iron, and are worked partly by atmospheric and partly by steam power. We furnish an engraving of one of the presses, and which is a *fac simile* of the whole of the twelve. In the centre of this small circle of machines an upright shaft, supporting a large horizontal fly-wheel, revolves, motion being given to it by bevelled gearing below. To the arms of the fly-wheel twelve cams are attached, and they project below the ring of the wheel. The wheel and cams overhang the whole series of presses, and are driven at a uniform speed of twenty-four revolutions per minute. Each press is furnished with a short lever of wrought iron at the top of its central or main screw. From the lever, a horizontal rod, seen in the drawing above the ring frame of the presses, passes through the wall of the apartment, and is attached to the upper, or "horse-head" crank of the vacuum pump. A compound lever arrangement, which the engraving reveals, and which is capable of adaptation to any amount of force required for cutting thick or thin blanks, connects the press with the vacuum pump.



It will be seen that below the ring-frame supporting the presses another lever is attached to the press-screw. This simply supports a curved buffer, which, at every stroke of the press, impinges upon an upright staff of ash recessed to receive it, and which breaks the shock of the blow.

As the cams pass in succession over the presses they strike upon friction rollers, one of which is attached to the upper lever of every press, and raise the press pin by giving it a partial turn upwards through its brass nut. The instant the cam has thus acted on one roller and advanced to the next, the vacuum piston comes into play by force of atmospheric pressure on its surface, the cylinder being open-topped, and brings down the press screw with its punch. The latter, which is of hardened steel, falls into a bed or bolster of its own diameter, and it is clear that a strip of metal, if interposed between the two, must be perforated by the operation. The attendant, seated beside the press with his strips of gold or silver beside him, takes advantage of each upward movement of the press-screw, and feeds the punches with the precious material in the intervals. Every downward stroke thus produces a blank coin, which falls into a catch-drawer or box beneath the press. The strips after they have been made to yield all the blanks possible, and are thus riddled from end to end, become scrap, and must be remelted. In our illustration some of the fillets in this condition are shown in a tray to the right of the operator.

In order to insure complete accuracy as regards the diameter of the blanks an assistant is constantly engaged in taking samples from the catch-box and weighing them. The instant the smallest error, if even to the extent of a fourth of a grain, displays itself the press is stopped, and the punch and bed are re-adjusted. Uniformity of size gives (closely approximating) uniformity of weight to the blanks, and to insure both the punches must be maintained of exact and truly gauged dimensions. The attendant at the press keeps his foot on a pedal if he wishes to maintain the movement of the machine, and removes it in order to stop its action.

At the close of a day's cutting the honeycombed strips are fagoted up for the crucible, in parcels of fifteen pounds weight each; the blanks are carefully examined, weighed, placed in bags, and sent forward for the next operation. With each bag a ticket noting the weight of its contents is despatched. Entries are made of apparent losses of metal or of differences of weighing, and the proceedings so far come to an end.

Multiple-cutting presses, punching two, three, or more blanks at each stroke, have lately been introduced at the mint. They are made by Messrs. James Watt & Co., and for bronze money answer very well indeed. In the case of gold or silver, single-punching machines are for the reasons given above quite indispensable.

(*To be continued.*)

YARN TWISTING MACHINERY.

(*Illustrated by Plate* 11.)

DURING the last eighteen months or two years many of the home and continental manufacturers have been endeavouring to produce an arrangement of mechanism for effecting the overtwisting of one or more yarns of one or more colours upon a ground or body yarn; the yarn itself being used in the weaving of cloths for the purpose of producing an elegant spotty appearance, that it has been a matter of much difficulty to obtain.

The origination of the peculiar appearance we have referred to is, we believe, due to the Austrians, from whom it was copied by the French; but the manufacturers in both these countries contrived so to hide the means they adopted for effecting it, that our home producers were prevented from ascertaining anything further than a mere examination of the samples that came to this country through the ordinary modes of trading.

Messrs. Sanderson, of Galashiels, were the first to try and produce the new yarn. They succeeded, we believe, in part; but by far the most effective arrangement is that forming the subject of the present notice. Next came Schott & Rosenthal with their arrangement, about which so much has been boasted. We believe this was tried at Saltaire; it certainly is a far inferior mechanical contrivance to Smith's. Tolson & Bury, and Turner, of Halifax, and Laidlaw, of Hawick, have each had their turn. Smith's machine certainly does not produce the yarn so rapidly as some of the others, but as regards the perfect manner in which it effects its work, it greatly surpasses all of them.

Fig. 1 is a part plan of the mechanism; fig. 2 is a transverse sectional elevation on the line *a*—*a*, fig. 1; fig. 3 being another transverse sectional elevation on the line *b*—*b*, fig. 1.

The framing, A, is of an open rectangular construction, and in it are fitted bearings for the prime motion shaft, B, on which are situated the system of fast and loose driving pulleys, C, which is driven by the belt, C^1. The shaft, B, carries also the two driving pulleys, D, figs. 1 and 3, over which belts pass for actuating the long drums, E, from which the several pirns, Q^1, carrying the spotting yarn are driven. The drums, E, are carried in bearings in the framework of the machine fixed to the bracket pieces, F, more particularly seen at fig. 2, to which the bearers, F^1, are fixed for carrying the rails supporting the guides, *f*, for the series of belts, *g*. Along either side of the frame, at a height above the ground convenient for the attendant, the starting rods, G, are situated, to which the starting handles, G^1, are attached, for the attendant to take hold of in sliding the rods, G, in a right or left hand direction, for the purpose either of starting or stopping the mechanism. The rods, G, are carried in brackets fixed into the framing at convenient distances along its length, and at the end from which the motion is first obtained, which in the present instance is the right hand end, a stud, *c*, is fixed, to which the cranks, *d*, on the horizontal shaft, H, are coupled, so that as the rods, G, are moved in either a right or left hand direction, the transverse rod, H, is rotated through an angle corresponding to the extent of horizontal movement of these rods, H, and with it the belt guide, I, so that the belt may be shifted on to either the fast or dead pulley as may be required, and the mechanism put in motion or stopped at will. It may be here explained that the machine being double, that is, of similar construction along both its sides, the description preceding and succeeding equally applies to both sides of the machine.

Referring now to fig. 2, the pinion, J, on the inner end of the shaft, B, gears into a corresponding spur wheel, J^1, which in turn gears into a pinion, J^2, on the axis of which is carried a smaller pinion, J^3, which next actuates the spur wheel, J^4, and on the same stud is carried, revolving with the wheel, J^4, the bevel pinion, J^5, seen at fig. 3; which in turn actuates the bevel wheel, J^6, and with it the horizontal transverse shaft, K. On either side of the wheel, J^6, is carried the star wheel, L, shown in enlarged detail at fig. 4. As the star wheel revolves the catch, M, is alternately pressed out from and drawn into the teeth or recesses in the peripheries of the star wheel. When the catches, M, are in the recesses or teeth, the lever, N, draws the conical clutch piece, N^1, into the conical cup or box, N^2, attached to the pinion, O, shown by dotted lines in fig. 3; the tension of the springs, O^1, always pulling the clutch piece, N^1, in the direction of the boxes, N^2, so that when the catch, M, is at the bottom of a recess between any two teeth in the star wheel, the tension of the springs, O^1, is sufficient to produce pressure enough to revolve the pinion, O, and actuate the gearing connected therewith.

On the central part of the top of the framing is situated the table carrying the pirns, Q, from which the main or centre thread is unwound as the twisting and spotting is produced; the yarn from these pirns is carried up over the rails, R, and downwards, thence through the tube in the centre of the horizontal pirn, Q^1, passing between the drawing rollers, W W, in the way as shown at fig. 2. On passing through the pirns, Q^1, the yarn is spotted and twisted over with the coloured yarn carried on the horizontal pirns, and in the spotted and twisted condition is conducted through the rollers, R and S, to the winding on bobbins, T. The twisting and spotting is produced in the following manner:—The thread or yarn on which the spots and twist are to be produced does not revolve, its motion being one of periodic translation forward only, and as the horizontal pirns revolve they twist the yarn producing the projecting spot and twist around the centre thread or body yarn, the spotting yarn being prevented from unwinding too quickly off the pirns, Q^1, by means of the retardation produced by the pressure of the little brushes, U.

Fig. 5 is an enlarged side elevation of a brush and its framing. The brushes, U, are fixed or carried on the end of a metallic rod, *e*, carried in a frame, e^1, which is movable on a central joint, e^2, so that when required the brushes may be lifted out of contact with the horizontal pirns, Q^1, by turning them round in an upward direction. Upon the joint, e^2, a short upright stud projects from the end of the rod, *e*, while the brush is carried so that weights, e^3, may be placed thereon for adjusting the pressure or retardation on the spotting yarn as it unwinds from the pirns, Q^1. The rod, *e*, carrying the brush, U, is adjustable in the tubular socket or body through which it passes, so that the brush may be brought to bear on any part of the pirn required. To produce the spots it is necessary that no forward translation or upwinding of the yarn on the bobbins, T, takes place during the time the spot is being formed; and to produce the helical or spiral twist thereon it is necessary that the yarn be carried forward. Thus it is obvious that whilst the spot is being produced, the gearing for actuating the bobbins by which they are caused to revolve for the purpose of winding on the yarn must stand still; this alternate stopping and movement is effected by the star wheels, clutches, and clutch boxes, L, N^1, and N^2, respectively.

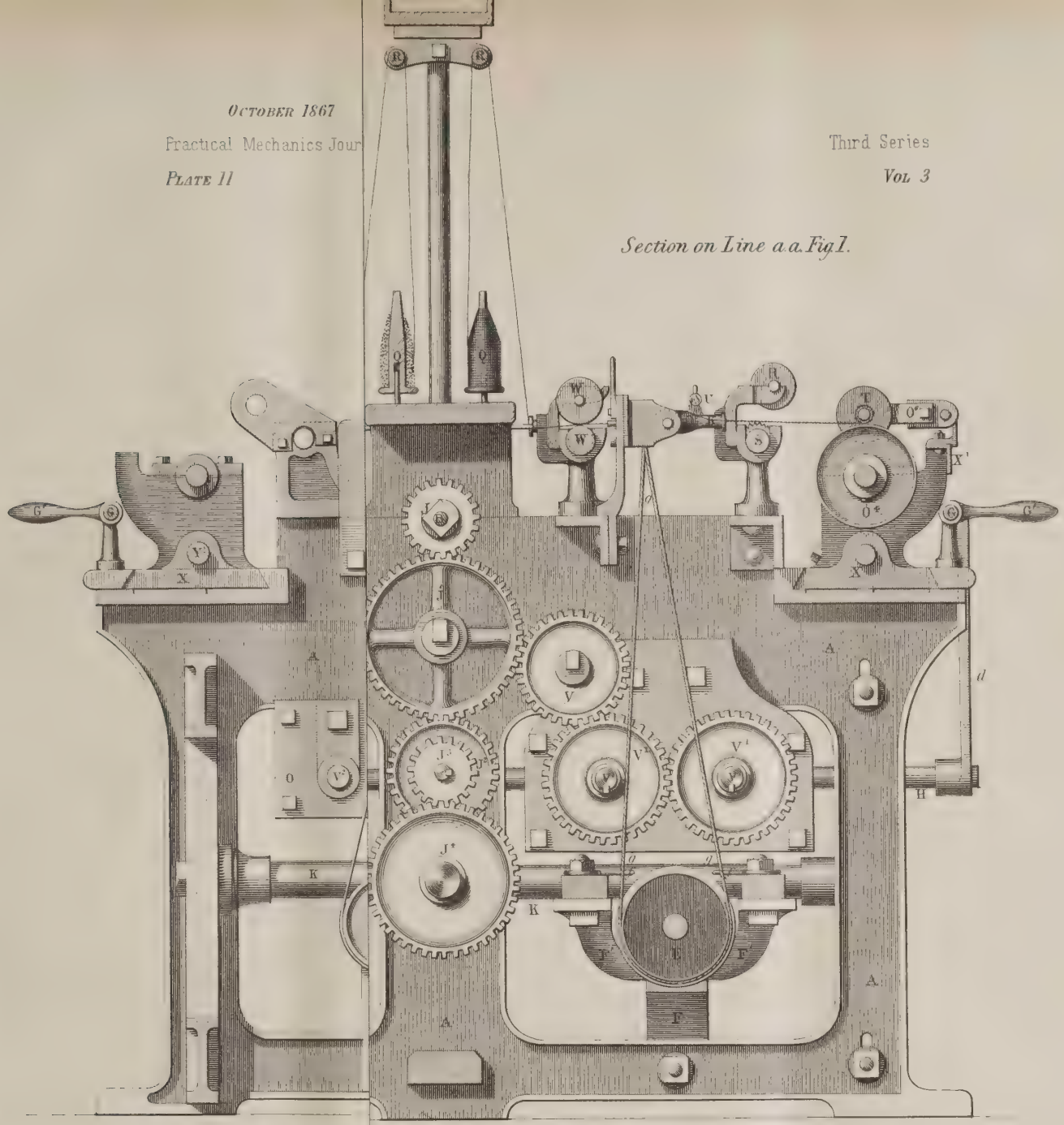
Referring again to fig. 2, the toothed wheel, J^1, drives on either side a toothed pinion, V, which again gears into and actuates another toothed pinion, V^1, on the short shaft, V^2. This shaft, V^2, carries the clutch, N^1, actuated in the manner before described, so that whilst the clutch is in its box, N^2, the pinion, O, is kept in rotation, and drives the toothed wheel, O^2, which again drives the train of pinions, O^3, shown at fig. 3, ultimately causing the slow rotation of the shaft carrying the frictional winding rollers, O^4, by means of the wheel, O^5, so that whilst the clutch is in gear with the box, N^2, the winding on of the yarn and the spiral twisting upon it of the spotting yarn is effected. The bobbins, T, are carried in suspension brackets, O^6, so that as the yarn winds on them their centres are removed to a greater distance from the rollers, the pressure produced by the weight of the bobbin and frame bearing on the surface of the rollers, O^4, being sufficient to produce enough friction to cause the rotation of the bobbins and the winding on of the yarn.

Whilst the star wheels throw the clutches, N^1, out of gear with the clutch boxes, N^2, the pinions, O, become stationary, consequently no upwinding of the yarn takes place, and it is during this period that the spot is produced by the successive windings of the spotting yarn upon one place of the main or central thread or body yarn. From what has now been set forth, with the aid of the accompanying engravings, it will be evident that a succession of stoppages and onward translations and upwinding of the yarn is produced, so that the spotting and twisting is rendered a continuous operation.

In addition to driving the upwinding gearing for actuating the bobbins, T, the wheel, O^2, also actuates the drawing rollers, W, by means of the pinion, W^1, by which the body yarn is drawn off the pirns, Q, prior to passing through the tube of the pirns, Q^1.

The shaft of the rollers, O^4, is carried in bearings fixed to the sliding carriages, both of which are coupled together by the shaft, Y^5, as well as by the angle-irons, X; and in order to perfectly fill the bobbins, T, with the yarn, it is necessary that it be evenly wound thereupon; the shaft and frame carrying the rollers, O^4, and the bobbins, T, is therefore moved slowly backwards and forwards through a distance corresponding to the length between the cheeks or heads of a single bobbin; the slow backward and forward movement is effected by means of the cams, Y, on the short shaft, Y^1, fig. 1, shown enlarged at fig. 8, carried in bearings as there shown. The cams, Y, on either side of the machine, are set in motion by the tangent screw, Y^2, on the shafts carrying the pinions, O^3; this tangent screw, Y^2, causes the slow rotation of a worm wheel situated below it, which cannot be seen in fig. 1, but is shown in enlarged detail at fig. 8. The cam, Y, is fixed on the same shaft as the worm wheel, so that as it revolves between the two antifriction rollers, Y^3 and Y^4, carried upon the bar, Y^5, it causes a slow reciprocating movement of that bar, and with it the frame and carriages supporting the series of winding rollers and bobbins, O^4 and T, respectively. When

Section on Line a.a. Fig 1.



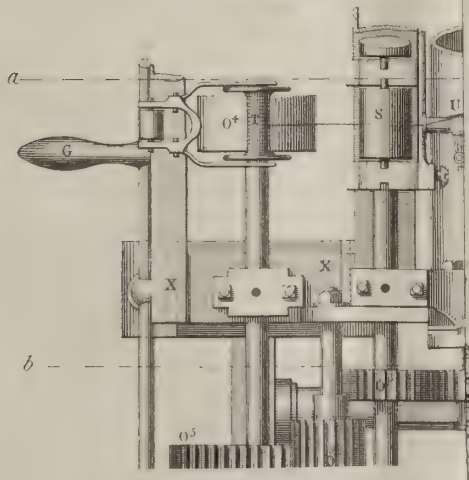


Fig 7

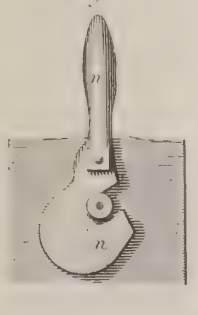
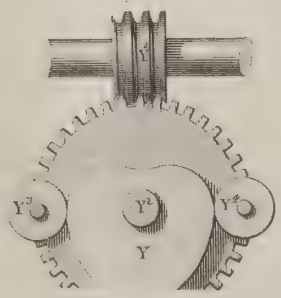


Fig 8



MACHINERY FOR OVERTWISTING YARN.

BY MESSRS ROBERT SMITH & SON

STIRLING.

OCTOBER 1867

PLATE 11

Third Series

VOL 3

Fig. 3.

Section on Line b. b. Fig 1.

Fig. 2.

Section on Line a. a. Fig 1.

Fig 1

Fig 4

Fig 5.

Fig 6

Fig 7

Fig 8

Scale for Figs 1 & 2

Scale for Figs 4 & 8

Scale for Figs 5 to 8

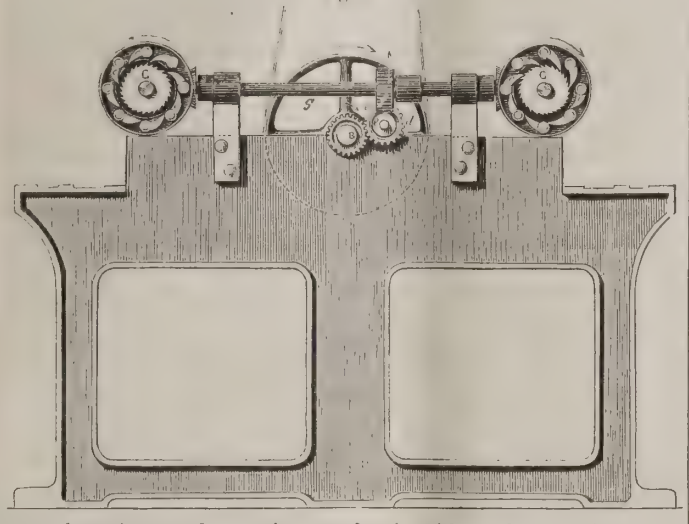
Patent Offices 47 Lincolns Inn Fields London,
and 166 Buchanan St Glasgow

required, the upper rollers of the pairs marked W and R respectively may be removed from bearing on the yarn, in which case they are placed in recesses made to receive their journals in the bracket carrying each pair; one of the upper rollers is shown in this position in fig. 2. The horizontal pirns, Q^1, shown enlarged at fig. 6, which carry the spotting yarn are rotated by the belt, *g*, passing over the small pulley, *i*, which carries the stop, i^1, that enters into a hole in the base of the pirn, for the purpose of rotating it. The central tube or tubular spindle, *k*, together with the outer head through which the main or centre thread passes, are made in one piece; and for the purpose of doffing a pirn, this tube, *k*, is withdrawn, after which the pirn may be drawn off the outer tube, k^1. When it is required to withdraw or to stop any one pirn without stopping the others, this may be effected by releasing the retaining catch, *n*, from off the inner end of the tube, *k*, in which case the pirns being carried in the little frame, *o*, fig. 1, their inner ends, together with the pulleys, *i*, drop or fall down sufficiently to slacken the belts, *g*, and elevate the outer end sufficiently to clear the rollers, S, in front of them; the frame, *o*, swivelling upon the pivots or bearings, *s*.

After a pirn, Q^1, is doffed, whilst the central tube or tubular spindle, *k*, is withdrawn, and the pirn frame, *o*, in the inclined position, another pirn may be placed thereon, after which the frame, *o*, is elevated and retained in its place by the catch, *n*, and the twisting and spotting continued as previously.

In place of producing a yarn having an alternate spiral twist and

Fig. 1.



spot, the twist may be continuous, that is, without the spots intervening, in the following manner:—The star wheel, L, is thrown out of gear, and the lever, N, being acted upon by the spring, O^1, keeps the clutch, N^1, and clutch box, N^2, in continuous contact, so that a constant upwinding movement is given to the rollers and bobbins, O^4 and T respectively.

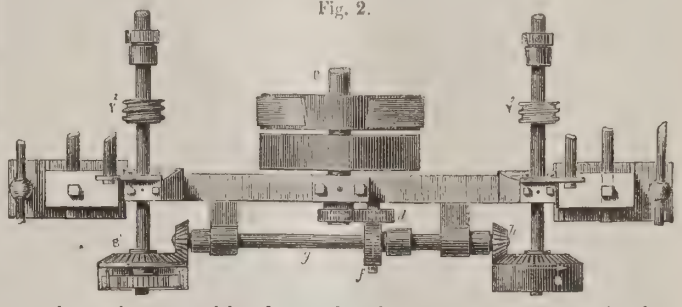
By introducing two star wheels, L, and two clutches and clutch boxes, with a double set of levers and springs for actuating them, what is called a diamond or back-lapped twist may be produced in the following manner:—Two pinions, O, are introduced, as shown in dotted line at fig. 3, both gearing with the toothed wheel, O^2, and which are capable from their own proper directions of motion to drive the wheel, O^2, and consequently the upwinding mechanism, in two different directions; so that after the yarn has been partly wound or drawn out through the central tubular spindle, it is partly wound back again, and the spotting yarn is also wound again over that part which it had previously passed, thus producing a diamond or back-lapped twist or spotting on the main or central thread.

In case it is desired to produce the spots and spiral or diamond twist at irregular intervals, this may be effected by making the recesses in the star wheel, L, at irregular distances apart, so that the upwinding of the yarn is produced at irregular intervals.

By means of the mechanism we have illustrated, together with the additional gearing shown at figs. 1 and 2 (woodcuts), a yarn may be produced having a long spot instead of the short one before referred to respecting the yarn first described. Fig. 1 (woodcut) is an end elevation of the framing of the machine, showing the additional mechanism for producing the elongated spots. The shafts on which the tangent screws, Y^2, are fixed are extended beyond the bearings, as shown at fig. 2 (woodcut); and on their exterior ends the bevel wheels, B^1, are fixed, the bevel wheels carrying the palls, *e*, being arranged so that the shaft may revolve independently of them, whilst the ratchet wheels, G, are fixed to the shaft.

On the outer end of the main driving shaft, B, a pinion is geared, which drives another stud pinion, *d*, carrying a tangent screw, *e*, which, in revolving, actuates the worm wheel, *f*, on the transverse shaft, *g*,

Fig. 2.



carrying at its extremities the two bevel pinions, *h*, which, gearing into the bevel wheels, B^1, cause them to rotate very slowly. Thus it will be evident that the slow motion of the bevel wheels is continuous, and that during the upwinding of the yarn at the time when the spiral twist is produced, their slow motion has no effect upon the shaft carrying the tangent screws, Y^2, since the clutch, N^2, fig. 4, being in gear, the upwinding gearing is actuated at the ordinary speed; but when the clutch is out of gear, and the spot itself being produced, a slow upwinding is effected through the revolutions of the bevel wheels, B^1, the palls in which, as shown at fig. 1, catch into the teeth of the ratchet wheels, D, and thus cause a slow upwinding during the time the spot is being produced; or, in other words, distributing the closely twisted portion of the spotting yarn over a greater length of the central thread or body yarn.—V. D.

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RECENT PATENTS.

TREATING YARNS.

J. Henry Johnson, *London and Glasgow.—A Communication from* E. T. C. Sutton, *Philadelphia.—Patent dated Nov.* 27, 1866.

This invention relates, firstly, to an improvement in yarn, and consists in the production of yarn from which the superfluous projecting fibres are removed, and which is thereby rendered equal in appearance to the finest German zephyr; and, secondly, to certain machinery or apparatus whereby the projecting fibres of yarn may be shorn off.

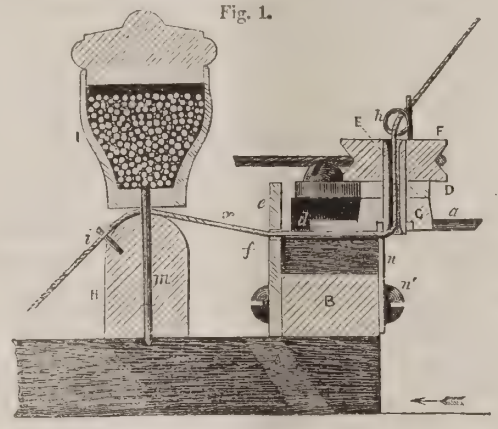
It is well known that the fine German yarn termed "zephyr" has a peculiar silky and smooth finish, which renders it of much greater value for knitting, embroidery, and manufacturing purposes, than other and coarser yarns. This may be attributed in a great measure to the quality of the wool used in Germany, the finest Saxony staples being employed in the manufacture of Berlin zephyr, which is also prepared in such a manner that the fibres are laid evenly. Where wool inferior in quality to that of the German or Spanish wool is used, the yarn spun from it is much coarser, owing for the most part to the innumerable fibres which project from the twisted strands, and which do not appear so prominently in the German yarn. It has been found that by cutting off these fibres close to the twisted portion or body of comparatively coarse yarn, the latter may be rendered equal, as regards smoothness and appearance, to the finest German zephyr. Although various devices may be employed for removing these superfluous fibres from the yarn, it is preferred to use the arrangements hereinafter described, and forming the second part of this invention.

Fig. 1 of the accompanying engravings is a longitudinal section of

one form of machine for shearing the strands or threads of wool or other fibrous material; fig. 2 is a plan view; and fig. 3 an enlarged sectional view of the shearing knives.

To a suitable table or base, A, is secured a frame, B, from which projects a bracket, D; and in the latter turns a vertical tubular spindle, E, provided at the top with a small pulley, F, and beneath the bracket with a heel, G, from which project four or any other desired number of

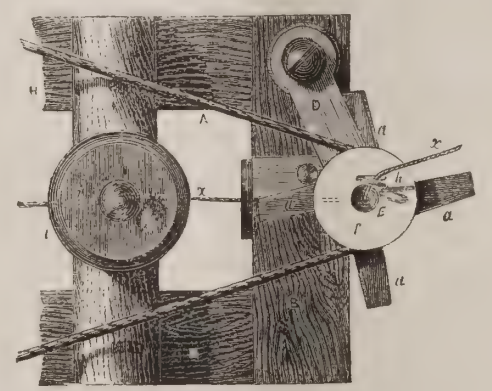
Fig. 1.



radial blades or knives, *a*. A stationary knife, *d*, is secured in such a position to the frame, B, that the under surfaces of the radial blades, *a*, shall revolve in close contact with the upper surface of the fixed knife, *d*, without bearing hard on the same. Both the revolving and the stationary blades are bevelled, and each is thus reduced to a sharp cutting edge, as illustrated in the enlarged view, fig. 3.

To the rear of the frame, B, is secured a plate, *e*, having an inclined slot, *f*, for the ready introduction of the yarn or thread, *x*, to be shorn, which traverses in a direction parallel or nearly so with the edge of the

Fig. 2.



stationary knife, *d*, and very slightly below the cutting edge of the same, as seen in the enlarged view, fig. 3.

The yarn passes upwards through the tubular spindle, E, and through an eye, *h*, formed by a wire secured to the pulley, F, a short distance from the centre of the same, the yarn passing from this eye to a suitable reel, round which it is wound. Prior to reaching the guiding plate, *e*, the yarn passes from an adjacent reel or "swift" round a pin, *i*, on a cross bar, H, secured to the base, A, of the machine, and between the rounded top of this bar, and the underside of a cup, I, which is loaded with shot or other small heavy particles, and which has a spindle, *m*, turning in the said cross bar.

The shearing of the yarn is accomplished rapidly and effectually by the above described mechanism.

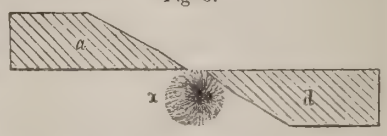
The tubular spindle, E, is caused to revolve very rapidly, while the thread is drawn forwards slowly in the course described above.

Owing to the position of the eye, *h*, as regards the centre of the tubular spindle, a twist is imparted to the yarn between the eye and the cross bar, H, three objects being attained by this twist. First, the yarn is turned round so that every part of it is subjected to the action of the knives. Second, the twisting has a tendency to condense and stiffen the yarn as it passes within the range of the revolving blades, which remove the projecting fibres only, the twisted and stiffened portions remaining entire. Third, the twisting has a tendency to make the superfluous projecting fibres more prominent, and consequently in the best condition to be severed. It should be understood that the twist imparted to the yarn between the eye, *h*, and cross bar, H, is but temporary, the strands being restored to their original condition on passing between the said eye and the winding reel.

It is important that an uniform tension should be imparted to the yarn as it passes in front of the knife; and this tension should be delicately adjusted to accord with yarn of different qualities or numbers. This tension is imparted by the cup, I, the weight of which may be regulated by removing or adding to the contents.

It will be seen, on reference to fig. 1, that the upper end of a pin, *n*, secured to the frame, B, projects into an annular recess in the underside of the heel of the knife. The yarn does not actually bear against this pin, otherwise the latter would interfere with the temporary twisting of the yarn, the pin merely serving as a guard to prevent the body of the yarn from being caught by the knives and severed, which might otherwise take place where any irregularity occurs in the yarn.

Fig 3.



A set screw, *o'*, passes also through a slot, *w*, in the guide plate, *e*, and into the frame, B, so that the plate may be adjusted vertically, and secured after adjustment. The thread, *x*, passes through the slot in the guide plate, *e*, through the recess, *t*, the tube, E, and eye, *h*, and is shorn between the knives in the same manner as in the machine first described. In this machine, however, the position of the yarn in respect to the knives may be regulated with the greatest nicety by adjusting the tubes, E, K, and the guide plate, *e*.

A number of shearing knives, with their adjuncts, may be arranged on one machine, so that a number of threads may be operated on simultaneously.

Although certain mechanism for shearing yarn has been described, it will be evident that these devices may be altered, modified, and other devices substituted for the same, without departing from the main features of the invention; for instance, a single revolving knife, or a vibrating knife, may be substituted for the rotary blades; both the upper and lower knives may be made to rotate or vibrate, or a spiral knife may be used in a manner somewhat similar to that employed in cloth shearing machines; in all cases, however, the turning of the yarn, and the guiding of the same, are essential.

Woollen yarn has hitherto been alluded to as the material to be shorn, but it will be evident that other twisted fibrous strands, even cordage, may be sheared by mechanism, equivalent to that described.

APPARATUS FOR GRINDING, CRUSHING, OR REDUCING DRY SUBSTANCES.

H. Wedekind, *London.—Communicated from* Fredk. Hoffmann, *Berlin.—Patent dated 30th October*, 1866.

This invention relates to certain peculiar constructions and arrangements of machinery or apparatus for grinding, crushing, or reducing dry substances; combined with a peculiar mode of, and apparatus for, feeding or supplying the substances to be ground, crushed, or reduced, and removing such substances, when sufficiently reduced, from the grinding or reducing surfaces, and depositing it in convenient receptacles.

According to one arrangement of combined apparatus suitable for pulverizing or reducing cement, sulphate of lime, brickdust, and similar hard and dry substances, it is proposed to employ a heavy or weighted rocking surface, consisting of a segment of a cylinder supported on, and rocking or rolling to and fro over, a stationary, horizontal, or flat surface or table of metal, or other suitable hard material, the material or substance to be reduced being suitably fed in, as hereinafter described, between the rocking surface, or rocker, as it is hereinafter called, and the flat surface. Any suitable mechanical contrivance may be adopted for imparting a rocking or to and fro rolling motion to the rocker; and the material may be fed in either externally to the rocker, or from the interior of the same, in which latter case the rocker would be made hollow, or in the form of a trough. In order to keep the rocker in its proper path whilst rocking over the table, and to prevent it slipping

thereon, it is proposed to employ curved guide rods, secured to the table, for the opposite edges of the rocker to work along; or a trunnion may be secured to the lower part of the rocker at each end, taking into a slotted seat on each side of the table, or (which is preferred) spur teeth may be fitted to or formed on each end of the rocker, gearing into straight racks secured to or formed on the edges of the table. It is obvious, however, that various contrivances may be adopted for the purpose referred to. A longitudinal reciprocating horizontal frame surrounding the rocker, and running upon wheels, or sliding along guide rails carried by the table, or suspended from a centre above, contains the appliances for feeding the material, for stirring or loosening the same between the crushing surfaces, and for removing the said material as fast as it is reduced to a fine powder. The longitudinal reciprocating motion of this frame should be in concert with the rocking motion of the rocker, and therefore it should derive such motion from the rocker itself, suitable connecting rods serving to unite the frame to the rocker at a point corresponding to the centre or axis of the cylinder, of which the rocker is a segment; or, in lieu of being a segment of a cylinder, the rocker may be otherwise curved so as to enable it to rock to and fro. To one end of the said frame there is fitted a feeding hopper, which discharges its contents on to an inclined surface which projects some distance under the rocker, and continuously supplies the materials to be crushed or reduced; whilst at the opposite end of the frame there is fitted a set of rakes or stirrers, the ends of which pass to and fro along the surface of the table, serving to loosen the crushed particles. In conjunction with these rakes there is a blast pipe and an exhaust pipe, the former serving to direct a number of small but powerful currents of air, generated by a fan-blower, into and amongst the crushed material immediately behind and underneath the rakes, thereby blowing up or separating the ready dust or powder directly it is formed from the coarser particles, which require still further reducing; the exhaust pipe serves to withdraw the dust or powder from the working surfaces whilst held in mechanical suspension in the air, and conveys it into a depositing chamber, where the fine particles are collected and gathered into receptacles, whilst the air, still carrying with it a certain amount of very fine dust, passes on to the same fan that produced the air jets, a portion of it thence passing into a second depositing chamber, as hereinafter described. The mouths of the blast and exhaust pipes are separated from each other by an inclined plate, to which the rakes are secured; and in order to check as much as practicable the inlet of fresh supplies of air to the exhaust pipe over and above that which is discharged from the blast pipe, and to avoid any inconvenience from the escape of pulverulent matter into the workshop, it is proposed to inclose the space wherein the air and exhaust pipes operate by means of side plates or cheeks attached to the frame, and fitting close against the ends of the rocker; a flap of leather, or other suitable flexible material, serving as a packing between the periphery of the rocker and the upper side of the mouth of the exhaust pipe, whilst a similar flap incloses the space between the surface of the table and the rear of the blast pipe. It will thus be seen that, supposing the packing above described be perfectly air-tight, the same air will be caused to circulate constantly through the apparatus; that which is forced in through the blast pipe being carried off, with the powder or dust held in mechanical suspension therein, along the exhaust pipe, and through the depositing chamber back to the fan, to be returned through the blast pipe, as already explained. Those particles which are too heavy to be carried away by the exhaust, drop on to the inclined separating plate, and are returned to the crushing surfaces again. The separation of the dust from the air is assisted by wire-gauze screens extended vertically across the depositing chambers. These screens may be shaken by elastic bands, or other convenient contrivance outside the chamber, to free them from the dust adhering to them. The air, almost freed from the dust or powder, arrives at the centre of the fan casing through a tube connected with the end of the first depositing chamber, when the fan forces the greater portion of it through the blast pipe back to the working surfaces of the crusher, the remainder being expelled through a separate orifice, provided with a regulating valve, into a second depositing chamber. The small portion of dust that may have been carried through the first chamber is deposited in the second, which is similarly provided with vertical wire-gauze screens for the air to pass through; whilst that portion of fine dust which may have been conveyed back to the crushing surfaces with the blast is not lost but drawn back again through the exhaust tube into the depositing chambers. The second depositing chamber has an outlet into the atmosphere, the air discharged therefrom being equivalent to the fresh air, which enters by leaking through the packing inclosing the working surfaces of the crushers; and as this will vary occasionally, the regulating valve in the inlet pipe to the second depositing chamber must be adjusted so as to allow an amount of air to enter such chamber corresponding to that which leaks through the packing. The above described depositing chambers, with the blowing and exhaust apparatus, may be applied together or separately to other forms or constructions of crushing, grinding, or reducing apparatus; as, for example, to stampers and crushing rollers, whether conical or cylindrical, the advantage obtained being an increased effective power by the instant removal of the dust or powder from between the working surfaces. In the conical roller mill a circular revolving table is employed, in combination with, say, four pairs of conical rollers revolving in fixed bearings over the table. The first pair of rollers are grooved or fluted longitudinally, and should be raised from ½ to 1 inch clear above the surface of the table, so as only to operate on pieces of larger dimensions than those given. The second pair should be grooved circumferentially, and situate at from ¼ to ½ an inch above the table, so as to crush those fragments which may have passed under the preceding rollers. The remaining two pairs of rollers may be plain, and in actual contact with the table. It is immediately behind these pair of rollers that the rakes and pneumatic blowing and exhaust apparatus are situate. In some cases the feeding apparatus may be omitted, and the feeding effected by hand; or the second depositing chamber may be omitted, and the blast taken direct from the atmosphere.

In all apparatus heretofore used for grinding or reducing substances, the dust or powder produced is not immediately separated from the granular unfinished coarse materials or substances, but remains in contact with them, and is exposed to the useless effect of the working machinery, which of course reduces the effective power to a large extent, this effective power being partly absorbed by the finished dust and pulverized materials. This is carefully avoided in the construction of the improved apparatus hereinafter more particularly described. The substances to be acted upon are spread on a plain surface, and are gradually crushed by a weight or a roller moving along the surface so as to press always on the materials to be pulverized.

This apparatus consists essentially of a weight, W; the lower surface consisting of a circle, or some other suitable curve, resting upon a fixed horizontal bed, B. If the weight, W, be pressed down on either side and then released, it will move backwards, and swing to and fro until its motion, counterbalanced by the resisting friction, is totally absorbed.

The resistance caused by friction is very slight, as a rolling friction only is produced. If the materials to be reduced are thrown into the path, B, within the limits in which the action of the rocker takes place, they will either (if sufficient power be not employed) effectually resist the rocking motion of W; or, if sufficient force be employed, the weight, W, will lift itself on to the top of the materials, and thereby crush them.

In this operation a complete development of the surface is prevented by the fragments between them, and a displacement of W takes place, which depends on the thickness of the layer of fragments produced at each rocking of the weight W. If the substances to be acted upon are equally distributed over the surface each time W moves backwards or forwards, the displacements of W will compensate themselves; but if this symmetrical distribution of the substances does not occur, the weight, W, should be provided with curved guides, trunnions, or dented segments, especially if the materials are continually thrown on B from one and the same side.

The momentum and weight of W should be in direct proportion to the bulk, solidity, and power of resistance of the materials or substances to be acted upon, and can easily be ascertained for each individual case. The only requirement is to impart to the weight, W, a continuous swinging or rocking motion, and to supply sufficient power to lift it on to the surface of the materials or substances, and to overcome the rolling friction and other resistance caused by the air, and by the guiding appliances, if used.

To this crushing apparatus there is added at one side a feeding apparatus, which continually supplies the materials to be crushed; whilst at the opposite side a discharging apparatus is provided, which separates or draws off the completely reduced product from the coarse materials.

The feeding of the apparatus, or the supply of fresh materials, takes place always from one side, whilst the rocker is in the position C, and likewise the clearing of the fully reduced or crushed product from the

other side, whilst the rocker assumes the position c′. But the feeding and removal of the material may also be effected from both sides; in which case, as before stated, the forward movement or displacement produced is neutralized each time the newly-supplied materials are being crushed.

The feeding apparatus may be differently constructed, in accordance with the nature of the substance to be crushed, but it receives its motion direct from the cradle or rocker, or from the motor of the same, at intervals corresponding with the swinging or rocking motions of the rocker. The material may be fed in either by a jolting motion or otherwise, and the supply may take place from the outside or inside of the cradle or rocker, in which latter case a hollow rocker is to be provided. The discharging or evacuating apparatus has a twofold function:—1. To separate the fine dust or powder directly it is formed from the coarse unfinished materials; 2. To extract the same from the working surfaces, and deposit it in separate chambers or receptacles. Rakes, points, or similar contrivances, stir the crushed material, and keep it open on the bed or path of the rocker, whilst, at the same time, air currents from below act upon these loose masses, and separate and raise the dust, while the coarse materials fall back and remain on the working bed. The dust carried by the air is led by means of tubes or pipes into chambers or receptacles, where the powder or dust drops, or is deposited. The current of air freed from the dust is brought back to the working apparatus, to be used in the same manner over again. As the supply of fresh material to the working surface of the rocker does not admit of an hermetic inclosure thereof, it would be impracticable to prevent a part of the dust-laden air from escaping, and so causing a loss in material if the air current attracted by the pneumatic depositing chamber did not allow part of it to escape freely through the second chamber

Fig. 1.

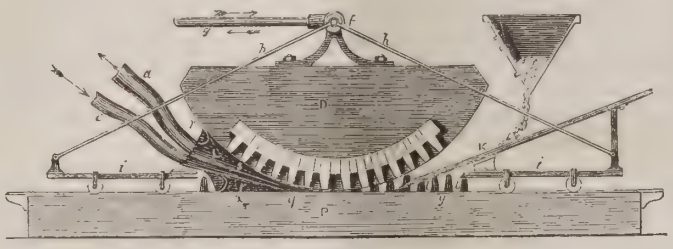
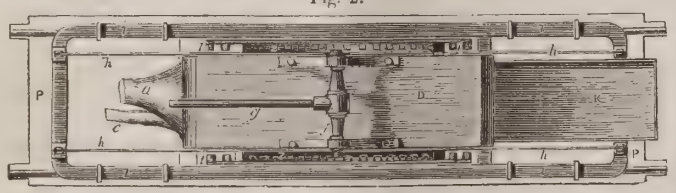


Fig. 2.



into the atmosphere. The dust still remaining in the air-current passing through the second chamber has ample opportunity to deposit there, and allow the air freed from the dust to escape. In this manner less air is supplied to the working surfaces than is taken from the pneumatic chamber; and the consequence is, that a vacuum being formed within the inclosure of the working surfaces, air is drawn in through the openings, and hence a loss or escape of dust or powder cannot take place. The rakes or points are compelled to follow the motion of the rocker, and move in correspondence with the feeding apparatus.

As a deviation in the regular performance of the rocker takes place through the supply of material to the horizontal working plane, provision must be made to remedy this defect, which can be done by employing a rack and pinion, sliding curves, or guides. If it is intended to reduce the material to grains of a given size, the apparatus may be constructed with two parallel curves, and horizontal planes or beds; the bed on which the work is to be performed being at such a distance from the corresponding rocker curve, that the grain already reduced to the desired size may be kept there without any further pressure; whilst the other horizontal planes with the corresponding curves only serve as travelling planes for the swinging of the rocker.

Figs. 1, 2, 3, and 4 of the engravings show the rocker, D, with the horizontal travelling plane, P, on which it works; the feeding apparatus, *k*, the pneumatic discharging apparatus, *l*, as well as the connection of the latter with the pneumatic depositing chamber, through the pipe, *a*, which leads the dust-laden air into the chamber, and the pipe, *c*, which leads the air, almost free from dust, back again between the working planes.

The lower working surface of the rocker, D, forms part of a circle of which the centre, *f*, will move in a horizontal direction during the swinging of the rocker, and the moving power can be communicated to the rocker by the connecting rod, *g*, or in any other convenient way. The rods, *h h*, suspended on the axis, *f*, communicate the oscillating

Fig. 4.

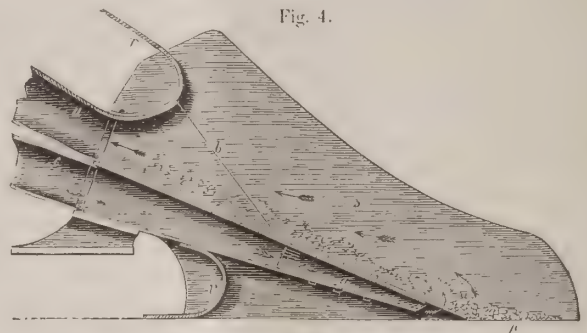
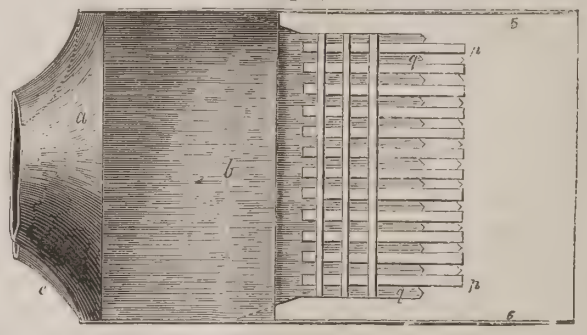
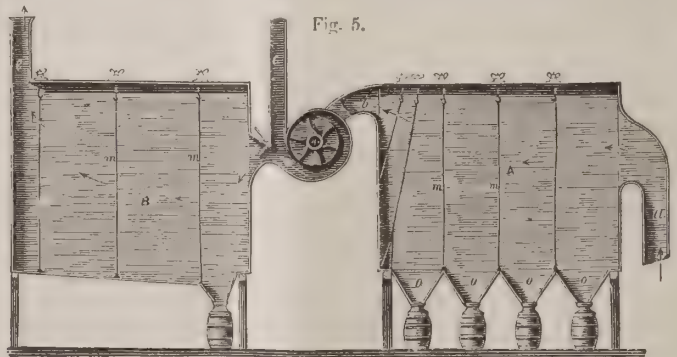


Fig. 3.



motion to the frame, *i i*, moving on wheels and rails, on which frame rest the feeding apparatus, *k*, through which fresh material is supplied, and also the pneumatic discharging apparatus, *l*, for the withdrawal of the finished dust. Fig. 3 shows the plan of the frame, *i i*. Fig. 4 shows the vertical section of the exhauster on a larger scale. Both the apparatus, *k* and *l*, are by this arrangement maintained at the same distance from the working surfaces of the rocker, D. Figs. 1 and 2 show the rocker in the central position, the working surfaces of the same extend from *x* to *y*, the whole length of which is covered with material by the feeding board, *k*. After the rocker has passed over this

Fig. 5.



material, the rakes, *p p*, loosen the same. The dischargers, *q q*, of the pipe, *c*, work in such a manner between the teeth of the rake that a number of fine but powerful air currents pass out under these teeth, and in ascending they carry with them and hold in mechanical suspension the lighter particles of dust or powder, whilst the heavier parts of the material are again dropped on to the working plane, where they will be further crushed or reduced on the return of the rocker. The pipe, *a*, on the other hand, being above the rake, draws in the cloud of dust produced by the scraper or rake, and conveys it to the depositing chamber. In order to separate the working space from the outer atmosphere, the packings, *r r*, and the thin plates, *s s*, are provided.

To the rocker are fixed on each side a toothed segment, *z*, which works in a rack, *t*, placed in or on the horizontal plane, P, to prevent the displacing of the rocker. The pneumatic chambers are shown at fig. 5. A is the first depositing chamber; C is a fan; B is the second depositing chamber. The fan when in motion produces a partial vacuum in A, and thus draws the air laden with dust or flour from the working surfaces by means of the suction pipe, *a*, into the chamber A. The length and section of A must be of such dimensions, that the air entering through *a* will move so slowly through A that the dust has sufficient time to sink to the bottom and fall into receptacles placed under hoppers, *o o*. The separation of the dust from the air is assisted by the wire gauzes or nettings, *m m*, which compel the air to move equally through the whole section of the chamber and arrest part of the dust, should the same come against the wire forming the gauze or netting, which should be regularly shaken by springs at *x x x*, to prevent the closing of the openings in the gauze. The air, almost freed from the dust, reaches the fan, C, through the tube, *v*, which blows it partly through the tube, *c*, back to the working surfaces, and partly into the second chamber, B, through the tube, *d*. The small portion of dust that the air carries from A, deposits in the second chamber, B, which is provided, like A, with gauzes or fine nettings, *n n n*, of such dimensions that even the last particle of dust will have time to settle before the purified air is allowed to return to the atmosphere through the opening *e*. The small quantity of dust which returns to the working surfaces through the tube, *c*, is not lost, but is drawn again through the tube, *a*, into the chamber, A. Thus the air is constantly circulating through the apparatus; and it is evident that the quantity of air escaping out of the chamber, B, corresponds with the air which is allowed to enter through the imperfect closing of the packings at the mouth of the suction tube, *l*; but as these imperfections cannot be accurately determined, and will not always be uniform, the pipe, *d*, is provided with a regulator, by means of which the section of the pipe can at any time be altered from the outside. If it were possible to avoid these imperfections in the packings, the air drawn in by the fan would all be blown on to the working surfaces again, and in that case the same air would be used over and over again. The above described pneumatic chambers, as well as the blowing and exhaust apparatus, may also be connected with other crushing and grinding apparatus or appliances—for instance, with stampers, crushing rollers, or collar stones, whether conical or cylindrical—and will afford considerable advantages by increasing the effective power through the instant removal of the dust or powder from between the working surfaces. The sucker, when in connection with the rocker, is compelled to follow the movements of the same; this, however, may be obviated by connecting the sucker as shown.

FIRE-ARMS.

J. Henry Johnson, *London and Glasgow.—Communicated by* S. H. Roper, *of Roxbury, Massachusetts, U.S., A.—Patent dated January*, 1867.

This invention relates, firstly, to repeating or revolving fire-arms, and is partly applicable also to single shooters, adapted to the use of the well-known metallic flanged cartridge, primed with percussion fulminate at its base; and secondly, to small-shot guns or fowling pieces. In carrying out the first part of this invention, it is proposed to combine a revolving carrier for holding the cartridges, contained within a fixed cylindrical case, with a piston or plunger sliding to and fro in one of the chambers of the carrier, such piston being connected by a link with the hammer or cock, and operating when the hammer is released or allowed to fall, in such a manner as first to drive the cartridge into the breech end of the barrel, and then, by the action of a sliding ball in the said piston or plunger, to explode the fulminate and fire the charge. The chambers in the revolving carrier do not consist of bored cylindrical cells as heretofore, but are merely open channels or deep grooves, the cartridges being retained therein by the fixed cylindrical case which incloses the carrier. An inclined plane is formed upon the rear end of the piston, and another inclined plane is provided on the head of the hammer or cock; the two inclines when the piston is driven forward tending to lock the said piston in its forward position, and thereby prevent its recoil. This combination of inclines may be employed either with a revolving carrier or with a stationary cartridge bed. A double-acting spring is employed for rotating and the locking the revolving carrier, such spring acting at one end against teeth of a ratchet wheel on the rear end of the carrier, whilst its opposite end is actuated by an eccentric slot in the foot of the hammer, which imparts the desired movement to the lever. A thumb-screw is inserted into the lock case, by means of which the front end of the double-acting spring may be secured, so that it cannot rise or act upon and turn the ratchet wheel and revolving carrier, in which position the carrier will be free to be revolved by hand. Or the thumb-screw may be carried to lock the spring in such a position, when the hammer is at full-cock, as to hold the carrier fast and prevent it from revolving, in which condition the arm may be used as a single loader, as the same groove in the carrier will be kept permanently in line with the barrel till the spring is again released by turning the thumb-screw. In lieu of attaching only one end of the mainspring of the lock to the hammer, it is proposed, either in repeating or in ordinary fire-arms, to attach both ends of the mainspring by separate stirrups, so connected with the front of the hammer that their connecting points are at right angles to each other in respect of the centre pin on which the hammer turns. By this arrangement the friction on the centre pin is considerably reduced. If the forward stirrup be set at a greater distance from the centre pin than the rear one, and is placed so that the spring acts upon the greatest leverage as the hammer is just finishing its stroke, the hammer will move with increased velocity from the beginning to the end of its stroke. The cover or case of the revolving carrier is provided with a hinged lid for introducing the cartridges, and a spring is fitted to the underside of this lid, which presses upon the cartridge with a view to holding the cartridge which is about to be fired steadily in its place. The second part of this invention consists in the employment of an attachable and detachable muzzle-piece to small-shot guns or fowling-pieces with a view to varying the scatter of the shot.

Fig. 1 of the engravings is a vertical longitudinal section of that portion of the gun which contains the lock, the revolving carrier, and

Fig. 1.

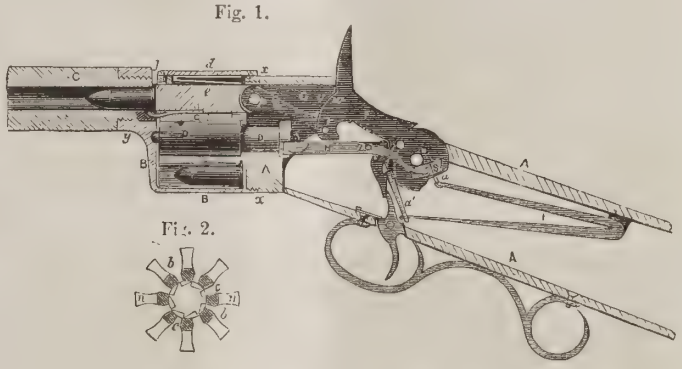


Fig. 2.

the rear end of the barrel, the hammer being down, as when the gun is discharged; fig. 2 is a rear-end view of the revolving carrier. A is the breech-piece or frame which carries the lock, the front end being cylindrical and forming the rear end of the cylindrical chamber which contains the revolving carrier; B is a cylindrical case, within which the carrier revolves, and which is screwed to the front cylindrical end of the breech-piece at X; C is a section of the barrel screwed to the cylindrical case at Y; D is a revolving carrier with the rear end of the axis, D′, extending through the front cylindrical end of the breech-piece, A, and having a ratchet wheel, E, on its rear end. The rear journal, on which this ratchet wheel with the revolving carrier turns, has its bearing in a plug or stud at the rear end of the bore, in which the axis, D′, and the ratchet wheel, E, are inserted, covering such bore in the rear; F is the hammer; G, the piston or breech-plug, and G′, a link connecting the piston with the head of the hammer; H is a double-acting spring, the front end of which moving in a narrow slot, formed by cutting away the side of the plug or stud immediately in the rear of the ratchet wheel, acts upon the ratchet so as to move the revolving carrier one-eighth of a revolution whenever the hammer is drawn back to full-cock, as will be hereinafter more fully explained. I is the mainspring which actuates the hammer. Each end of this spring is connected with the foot of the hammer by means of a separate stirrup, *a* and *a′*, and these stirrups are so connected with the foot of the hammer that their connecting points are at right angles to each other in respect of the centre pin on which the hammer turns. The forward stirrup, *a′*, is attached to the foot of the hammer at a greater

distance from the centre pin than the rear one, and is so attached and arranged that the spring acts upon the greatest leverage as the hammer is just finishing its stroke, so that the hammer moves with an increasing velocity from the beginning to the end of its stroke. These two stirrups, connecting each end of the mainspring with the hammer as aforesaid, tend to lessen the friction on the centre pin. The revolving carrier is somewhat similar in form and construction to the revolving cylinder in an ordinary revolving fire-arm, except that instead of being bored with a series of charge chambers, it has a series of nearly semicircular grooves, as shown at *b*, fig. 2, into which the cartridges may be inserted, laterally. The cylindrical case, B, holds the cartridges in their places, and it has an opening in its upper side through which they are inserted, with a hinged cover, *d*, and a catch to fasten the cover when it is closed down. On the under side of the cover there is a spring, *e*, which presses lightly on the cartridge, in order to hold it steadily down in its bed, and secure the effective action of the retracting hook upon it, as well as to accommodate the cover to any slight variations in size in the flanges of the cartridges. The cylindrical case, B, has a round hole in its front end immediately in rear of and in line with the barrel, through which the cartridge passes when it is pushed forward from its bed in the carrier to the barrel. It has a similar bore in its rear end, also in line with the barrel, extending back through the breech-piece, A, to the point where the hammer strikes, in which bore the piston moves. The piston, G, has neatly dovetailed into it longitudinally a percussion bar, *o*, which is rather longer than the piston itself, the front end of which being driven against the flange of the cartridge by the hammer as it completes its stroke, explodes the fulminate. The wings of the revolving carrier, which separate the cartridge chambers or beds, are bevelled at their rear ends, so that in moving past the end of the percussion bar they present to it inclined planes, *n n n*, fig. 2, and on coming in contact with it will slide the bar back, so as to pass it freely. The link, G′, which connects the piston with the head of the hammer, is composed of a thin plate of steel, and its front portion is inserted in a central longitudinal and vertical slot in the rear end of the piston, to which it is pivoted at *p*. The rear end of the said link is inserted in a slot in the hammer head, to which it is pivoted at *r*, this pivot passing through an elongated hole or slot in the end of the link to allow the necessary play as it moves into line with the piston or departs therefrom. The rear end of the piston is bevelled on its lower side, as shown at *v*, so that when the hammer is down, as shown in fig. 1, the inclined plane, *v*, of the piston bearing against the inclined plane, *u*, of the hammer head, completely locks the hammer against the possibility of being raised or thrown back by the recoil of the piston. The hammer is, in fact, thus secured against the possibility of being thrown back by any recoil of the piston before it has completed its stroke, or from the time that the said inclined planes, *v* and *u*, come in contact with or in opposition to each other. The spring, H, is pivoted to the breech-piece or frame, A, at *i*, and the rear end has a laterally projecting head, which moves in an eccentric slot, *s*, in the foot of the hammer, whilst the front end presses laterally against the ratchet wheel. As the hammer is drawn back the rear end of the spring is depressed by the eccentric slot or cam, *s*, in the foot of the hammer, causing the front end to bear upwards against a tooth of the ratchet wheel, which it prevents from revolving, however, so long as the piston remains in the groove of the carrier, but so soon as the piston passes out of the groove the spring acts instantly upon the ratchet, and throws the carrier forward until the next groove comes in line with the barrel. As the hammer descends the rear end of the spring rises, causing its front end to fall below the ratchet, and out of the way of its teeth. A thumb-screw is set in the frame, A, the position of which is shown in red lines at *l*, by means of which the front ends of the spring may be secured in the position last mentioned, or as shown in fig. 1, so that in drawing the hammer back the said front end of the spring will not rise or act upon the ratchet. When the front end of the spring is thus kept down by the thumb-screw, the carrier may be revolved freely by manipulating it with the fingers, for the purpose of cleaning or recharging it. The arm may thus be used as a single loader, as the same groove in the carrier will be kept permanently in line with the barrel till the spring, H, is again released by turning the thumb-screw. The front end of the piston is provided with a hook, *h*, for retracting the cartridge, and in the bottom of each cartridge bed there is a narrow groove, *c*, for the said hook to run in. There is an open space, *j*, between the magazine or cylindrical case, B, and the barrel, completely separating the barrel in which the cartridge is exploded from the magazine. This affords a protection against fouling and premature explosion of cartridges in the magazine in case of bursting the cartridge flange, as may sometimes occur. The revolving carrier or magazine is charged with cartridges by dropping them successively through the opening, *d*, as the carrier is revolved, the hammer standing at full-cock. When the carrier is completely charged the cover is shut down and fastened. The gun may then be fired as rapidly as it can be cocked and snapped, until all the cartridges are exhausted. As the hammer goes down it pushes the piston forward, the head being all the time firmly pressed against the rear end of the piston, and, as the hammer completes its blow, it is in a position to receive the recoil of the piston, and present a firm and secure resistance thereto. The piston pushes the cartridge before it into the barrel, and just as the cartridge is fairly pushed home, the hammer in completing its stroke drives the percussion bar, *o*, forward, and explodes the fulminate. As the hammer is drawn back the hook, *h*, seizing the empty cartridge shell by its flange, draws it back into the same bed from which it has been pushed forward, and at the instant when the front end of the piston passes behind the rear end of the carrier, the spring, H, throws the carrier suddenly forward, so as to bring a fresh cartridge in line with the barrel, whilst the empty shell is moved on the same distance. The gun may be discharged at the half or at the full cock, but to discharge it at the half-cock, the hammer must first be drawn back to the full-cock, in order to withdraw the piston, so as to allow the carrier to revolve. The hammer may then be let down slowly, pushing the cartridge into the barrel, and may afterwards be drawn back to the half-cock when it is desired to discharge the gun. It is manifest that this part of the invention is applicable to a single shooter as well as to a repeater. Instead of a revolving carrier there may be a single stationary bed for the cartridge, and thus by means of the same mechanism a good single-shooting breech-loading gun may be produced.

The second part of this invention, which is applicable to shot guns only, is not illustrated. It is well known that some shot guns will scatter the shot much more than others of the same calibre. Repeated experiments have shown that the scatter of the gun depends mainly upon the shape of the extreme end of the barrel or muzzle, and that the same gun may be made to scatter or shoot close by expanding or contracting the muzzle. It is well known to sportsmen that in some kinds of shooting it is desirable to have the gun scatter its shot more widely than in other kinds. The object of this part of the invention is to produce a gun which may be easily and readily converted into a close shooting or scattering piece, as circumstances may require, and it consists in providing an attachable and detachable muzzle to vary the scatter of the shot by attaching it to, or detaching it from, the barrel.

REVIEWS OF NEW BOOKS.

THE MINING AND METALLURGY OF GOLD AND SILVER. By J. ARTHUR PHILLIPS, Mining Engineer. 1 vol. thick royal 8vo, with illustrations. Spon, London. 1867.

THE British press has sent forth no work on any branch of metallurgy for very many years past of as much pith and merit as this upon the mining and metallurgy of the precious metals, or two of them; for the author only deals with the metals of coinage, gold and silver, and says nothing of platinum or its naturally allied metals, all of which, in certain senses, are precious metals.

Mr. Phillips' work, which, in its type and admirable illustrations, has been done full justice to by his publisher, consists of two nearly equal divisions; the first, which refers to gold, consisting of eleven well-written chapters, and the second, which treats of silver, of twelve. There is not one bit of diffuseness or wordy filling stuff in the volume, which is written in a condensed, clear, and to all, intelligible style, and is exuberant of valuable matter.

The author is not unknown as a practical mining engineer, connected with various large metallurgical establishments, and one who has enjoyed the advantage of repeated visits to, and residence in, several of the most important mining regions of Europe and of America. As a practical man he writes a practical book; and states in his preface that he does not purpose to meddle with theory more than may be necessary for the orderly setting forth of results, or the *rationale* of facts or of processes

described. In the case of each of the two metals with which he deals he commences by a chapter giving their modes of occurrence in nature, and the geological position of each respective metal. In these chapters a succinct account of the mineralogy of each metal, of the ores of gold and of silver, is included.

For some time the bold and, in its results, important generalization of Sir Roderick I. Murchison, as to the geological position of the gold formations, viz., that they were to be found in or below the silurian rocks, and in the eruptive rocks that penetrate or metamorphose them, appears not to be unexceptionally true. There seem now good grounds for supposing that auriferous quartz veins exist in formations as recent as the jurassic, and that thus such veins or stores of gold in a diffused form may be found, from these recent limestones down to the sienites of the Ural (which contain gold diffused in their mass), and to the schists, or perhaps gneissose rocks of Russian Siberia. The relations of gold—that strange metal, the only one (excluding platina) which may be said always, or nearly so, to occur in the native or metallic state—to the general geognosy of our globe are, however, as yet almost unknown. Baron Richthofen, an eminent mining and geological authority, is understood to be at present occupied with the study of this question in California, and probably will present many new and important facts as the fruit of his investigation of that vast and important metallurgical region. Whenever the true cosmical relations of gold and silver, but especially of the former, shall have become clear, there can be little doubt but that these will throw reflectively a flood of light, upon the early conditions of the formation of the surface of our planet as we now see it.

Though by no means certain either, a very general impression prevails amongst gold miners that quartz veins decline in richness with depth, and that in this respect gold follows a fact supposed (within the narrow limits of mining observation) to apply equally to copper, silver, and tin in veins, if not indeed to all metals. One can scarcely avoid hazarding the speculation, whether thus there may not be interposed between the superficial metallic riches which alone we are permitted as yet (if not for ever) to know, and the deep interior of our globe, a spherical shell of rocky matter, poor in, if not devoid of, metallic mineral wealth—nothing in fact but a vast shell of enormous thickness, consisting wholly of the oxidized metals of the earths, with silica and iron; but that below this again there may exist masses of unoxidized, or possibly of haloid compounds of the heavy metals, and amongst those of gold, platinum, and silver, sealed up for ever from the hand of man, though no doubt destined for some important final end, masses of precious metals to which the wildest imaginings of oriental fable would fail to fix dimensions, much less value. If it be not so, it is difficult to conceive any state of things that shall account for the facts, as certain as any in the whole range of physics, viz., that while the mean specific gravity of the formations of our earth down to some 20 miles deep from the surface does not exceed 3·0 or 3·5, the *mean* specific gravity of our globe as a whole, exceeds 5·0.

The greatest source of difficulty in investigating the geological position of gold arises from the fact that its rich deposits, whether in veins or disintegrated, are found in regions covered with enormous depths of diluvial material, and which has been subject to the grinding, and wash, and sifting, and transposition of tidal action probably beneath the sea; of ages of slippage, as banks beneath the waves; and afterwards to ages of pluvial and torrential action in air, and to landslips and the rest of the vast machinery by which loose material is for ever being shifted and comminuted on our globe's surface. After such changes the chronological geology, so to speak, of any country so covered, becomes a work of years, and often of uncertainty to the end.

In the successive chapters of the first part of this work, we have a short account of the gold regions of the Old World, including China, Japan, and Africa; then of the North American continent, on the Atlantic and the Pacific sides, in the latter of which an excellent account is given of the Californian methods of gold-getting. We then go to Mexico, Central and South America, our North American Colonies, Australia, and New Zealand.

The eighth and following chapters comprise good and practical accounts of the methods of gold mining or washing and amalgamating in use in California, Australia, Hungary, and Brazil. In the last of these chapters we have something on the subject of the Sodium Amalgam, which has been patented by Mr. Crookes. The palm of first invention of this is said to be disputed with Mr. Crookes by a Dr. Wurtz, of New York, who applied for his patent in November, 1864, whilst Mr. Crookes' dates from February, 1865, in England. So far as priority of discovery of the *fact* that the alloy of sodium in very minute quantity with mercury powerfully exalts the affinity of the latter for all metals, enabling it to amalgamate with some, such as copper and iron, with which otherwise it will not amalgamate at all, and of the *suggestion* that this might probably prove of great value in assisting in the amalgamation processes for obtaining the precious metals, we have the very best authority for being able to state that both Mr. Crookes' and Dr. Wurtz's claims to priority must yield to a long anterior claimant. We are informed that Mr. Mallet, upon the occasion of the earliest meeting of the British Association at Newcastle-on-Tyne, stated openly in the chemical section that he had observed the above facts in connection with his methods for galvanizing the iron of iron ships, by means of an alloy of zinc and sodium, a method which he patented, and he then suggested the applications as above also. The general fact of the powerful exaltation of affinity for alloying produced by sodium, is explicitly noticed in one of his reports (the third, we believe) on the action of air and and water on iron, in the volumes of the British Association Reports.

This, however, is to digress. The last chapter of the first part, like that of the second, comprises a *resumé* of the methods of assay for gold and silver respectively. These chapters are necessarily brief, and cannot be expected to be exhaustive. A simple approximate method of determining the richness in gold of quartz, derived from the ancient mode by which Archimedes fixed upon the fraudulent alloy put into the crown of Hiero of Syracuse, is given at p. 236.

If g = the specific gravity of gold = 19·00,
Q = that of quartz = 2·60,
m = that of the mixture of gold and quartz,
x = the *bulk* of gold in relation to an unit of *bulk* of the auriferous quartz;

then gx = the proportionate *weight* of gold, and $(1 - x)\,Q$ = the proportionate weight of quartz, and the sum of these is the weight of the unit of the mixed gold and quartz, or

$$gx + (1 - x)\,Q = m;$$

whence

$$x = \frac{m - Q}{g - Q} \text{ for the } \textit{bulk} \text{ of gold;}$$

and for the weight,

$$\frac{gx}{m} = \frac{g}{g - Q} \times \frac{m - Q}{m}.$$

Then follows a capital little table for finding, on inspection, the yield in gold of 10,000 ounces of auriferous quartz, whose specific gravity is known.

In part the second we are again taken round the world in company with the Genius of silver, and of this part of the work we wish we could afford more room to speak of it as it deserves. The description given of those most curious and ancient processes adopted by the Spaniards originally in Central and South America, is one of the best we have seen in English. It is a most remarkable thing that this singular process of the "Patio" should have been brought to perfection in the very infancy of modern chemistry, and yet that chemistry has not even yet quite cleared up all the complex and curious reactions that go on in the elements of the ores and the materials added to them. Some very interesting researches on this subject have been made, by Domeyko we believe, and were published some time ago in the "Annales des Mines."

The various other and more modern systems of amalgamation—the Freyberg, Real del Monte, Nevada methods, that by the various forms of amalgamation pan, as well as the processes of Augustus Ziervogel and Von Patera, are all described. Lead refining for silver is then treated of in a separate chapter, and some very curious and recently observed facts as to the volatility in fusion, of both gold and silver, but especially the latter, are given, concluding with cupellation. Finally, we have the smelting of the argentiferous galenas of Pontgibaud, in the Puy de Dome country of France, and of the ores of Mexico. The work worthily fills a gap hitherto vacant in English metallurgical literature, and unless we much mistake will be widely recognized as having worthily done so.

To the mining engineer and metallurgist we need say nothing in recommendation beyond the suggestion to look into the book and form

their own judgments. In these our days when gold is playing so wonderful a part in changing the face of society and working wonders of every sort, every one must take an interest in learning how the 600,000 pounds troy of gold, which is at present about, it appears, the total annual production of the whole world, is obtained, as well as hearing whence and how the 4,000,000 and odd troy pounds annually of silver are procured. To all such, no more animated and graphic accounts, in survey of the whole world,

"From China to Peru,"

need be offered, than Mr. Phillips' book.—Ed.

CORRESPONDENCE.

☞ We do not hold ourselves responsible for the views or statements of Correspondents.

WOOD WORKING MACHINERY IN THE PARIS EXHIBITION.

(*To the Editor of the Practical Mechanic's Journal.*)

Sir,—An official report of English wood working machinery has been published in the *Illustrated London News* of August 3, in which commendation has been accorded to several exhibitors of the above description of machinery, and to which, no doubt, they are entitled. Without imputing any motive, I think justice has not been done me by the total omission of my name from this report, as it is to me that the only silver medal, the highest prize in this section, has been awarded. The expense and pains on my part of contributing to the English display of machinery (mine being all in motion) has, of course, been very great, and it certainly is not unnatural for me to expect to be at least mentioned in connection with the others; and, moreover, it appears to me a very poor compliment to the jurors "to make conspicuous by its absence" the name of the recipient of the highest award.

I am, &c.,

S. WORSSAM.

OBITUARIES.

MICHAEL FARADAY, F.R.S.

With universal regret have all the enlightened circles of Europe, during the past month, received the tidings of the death of him whose name had become familiar to most people, and beloved not alone for the simple earnestness and successful achievements in the development of physical truth by its possessor, but esteemed of higher worth by those whose fortune it was to come within the pale of influence of his private life—that life known to us from the first moment its object was communicated to Davy, ever budding fresh, apart from all else, with so many of those virtues not only that make up the life of a rightly living man, but constitute, moreover, all that is intended in the meaning of the true gentleman. The story of his early life is well known: he was born in 1794, of extremely humble parentage, and in every sense was a self-made man, receiving but the most scanty education at the hands of his parents. Still, notwithstanding all these early difficulties, they were overcome, and our country appreciates the eminence to which he rose. With such minds as his a little goes a great way; he neglected no opportunities for self-improvement. He was apprenticed by his father to Riebau, a bookbinder in Blandford Street, London, in whose service he remained until the year 1812. During the time he was Riebau's apprentice his desire to study science appeared, and his talents displayed themselves in the construction of an electrical machine and other apparatus, which was one day caught sight of by his master. This Riebau must have been a goodnatured man, and did not neglect his pupil's taste on this occasion, like most other employers of labour would have done. Riebau was one day shortly after attending to the commands of a customer, Mr. Dance, of Manchester Street, London, who was so much struck with the ingenuity of the young bookbinder, that he was induced to take the boy with him to hear the last four lectures that Davy delivered as professor. This was the turning-point in Faraday's career: he took notes of the lectures, copied them out, and the use he made of them may be gathered from the following letter which he afterwards wrote to Dr. Paris:—"My dear sir, you asked me to give you an account of my first introduction to Sir H. Davy, which I am very happy to do, as I think the circumstance will bear testimony to his goodness of heart. When I was a bookseller's apprentice, I was very fond of experiment, and very averse to trade. It happened that a gentleman, a member of the Royal Institution, took me to hear some of Sir H. Davy's last lectures in Albemarle Street. I took notes, and afterwards wrote them out more fairly in a quarto volume. My desire to escape from trade, which I thought vicious and selfish, and to enter into the service of science, which I imagined made its pursuers amiable and liberal, induced me at last to take the bold and simple step of writing to Sir H. Davy, expressing my wishes, and a hope that, if an opportunity came in his way, he would favour my views; at the same time I sent the notes I had taken at his lectures. The answer, which makes all the point of my communication, I send you in the original, requesting you to take great care of it, and to let me have it back, for you may imagine how much I value it. You will observe that this took place at the end of the year 1812, and early in 1813 he requested to see me, and told me of the situation of assistant in the Laboratory of the Royal Institution, then just vacant. At the same time that he thus gratified my desires as to scientific employment, he still advised me not to give up the prospects I had before me, telling me that science was a harsh mistress; and, in a pecuniary point of view, but poorly rewarding those who devoted themselves to her service. He smiled at my notion of the superior moral feeling of philosophic men, and said he would leave me to the experience of a few years to set me right on the matter. Finally, through his good efforts, I went to the Royal Institution, early in March, 1813, as Assistant in the Laboratory; and in October of the same year went with him abroad, as his assistant in experiments and in writing. I returned with him in April, 1815, resumed my station in the Royal Institution, and have, as you know, ever since remained there." Sir Humphry's note was as follows:—"December 24, 1812. Sir, I am far from displeased with the proof you have given me of your confidence, and which displays great zeal, power of memory, and attention. I am obliged to go out of town, and shall not be settled in town till the end of January: I will then see you at any time you wish. It would gratify me to be of any service to you. I wish it may be in my power. I am, Sir, your obedient, humble servant, H. Davy.' All this is as illustrative of Davy as of Faraday, and equally honourable to both. It links the history of the one to that of the other.

On returning from the Continent his after life was spent in the prosecuting of studies and researches in physical science. In 1821, while assisting Davy in pursuing the investigation of the relations between electricity and magnetism, first started by Oersted, he made the discovery of a convertible rotation of a magnetic pole and an electric current, which was the prelude to his splendid series of experimental researches in electricity. These investigations procured him the honour of being elected corresponding member of the Academy of Sciences in 1823, and Fellow of the Royal Society in 1825. In 1827 he published his first work, a volume on "Chemical Manipulation;" and in 1829 he was appointed chemical lecturer at the Royal Military Academy at Woolwich, a post he held, in conjunction with his duties at the Royal Institution, for many years. In 1831 his first paper appeared in the "Philosophical Transactions" on the subject of electricity, describing his experimental studies of the science, and from that time for many years the "Transactions" annually contained papers by Faraday giving the method and results of his investigations. These papers, with some others contributed to scientific journals on the same subject, were subsequently collected at different intervals in three volumes under the title of "Experimental Researches in Electricity." The first volume appeared in 1839, and contained the contributions to the "Philosophical Transactions" up to that date. The second volume was published in 1844, and the third in 1855. It is not too much to say that by the experiments thus described Faraday formed the science of electricity. He established the identity of the forces manifested in the phenomena known as electrical, galvanic, and magnetic; he ascertained with exactness the laws of its action; he determined its correlation with the other primal forces of the natural world. While he was still pursuing the brilliant career of investigation which thus proved so successful, the chair of Chemistry was founded at the Royal Institution in 1833, and Faraday was naturally appointed the first professor. In 1835 he was recommended by Lord Melbourne for a pension of £300 a year, in recognition of his great distinction as a discoverer. From that time his career has been one of increasing honour. Oxford conferred on him an honorary degree upon the first occasion of the meeting of the British Association at the University. He was raised from the position of corresponding member to be one of the eight foreign Associates of the Academy of Sciences. He was an officer of the Legion of Honour, and Prussia and Italy decorated him with the crosses of different orders. The Royal Society conferred on him its own medal and the Rumford medal. In 1858 the Queen allotted him a residence at Hampton Court,

between which and Albemarle Street he spent the last years of his life, and where he peaceably died on Sunday, August 25. The belief in the disinterested zeal and lofty purity of life of the students of philosophy, which, as his own letters show, was one motive for Faraday's petition when a lad to Davy to enable him to become a servant in the humblest walks of science rather than to spend his days in the pursuit of trade, was redeemed by Faraday's whole life. No man was ever more entirely unselfish, or more entirely beloved. Modest, truthful, candid, he had the true spirit of a philosopher and of a Christian, for it has been said of him

'Gladly would he learn, and gladly teach.'

The true monument to the man will ever remain in his undying work of life; and now that this is over, we have reluctantly to take our leave of him, *Requiescat in pace.*—V. D.

M. JULES PELOUZE.

Amongst the foreign scientific men who have recently passed away, few will have left so great a blank as the eminent chemist M. Jules Pelouze, who but a few weeks since presented the result of his recent labours to the Institute of France, and who in full health and vigour was struck down by the severe domestic affliction which he experienced in the sudden death of his wife, one of the most excellent of women.

Without giving any detailed account of his labours, sufficient will be gleaned of the sterling worth of one whose reputation was universal, and whose memory will always be held in affectionate remembrance by those who knew him.

Jules Pelouze was born at Valonges (Manche) in 1807. After receiving the elements of his education he removed to Paris, where he entered upon a course of study at the School of Pharmacy, and became a pupil of the celebrated Gay-Lussac. This professor early noticed the peculiar aptitude of the young student for chemistry, and under the tuition and guidance of that great man, M. Pelouze gave early indications of the genius and skill which eventually placed him in the first rank of the most distinguished chemists of our day. In the laboratory of Gay-Lussac he diligently laboured, and whilst there he published several original chemical investigations. He was early appointed Repétiteur in Chemistry to his former professor at the Polytechnic School, and eventually succeeded him in the Chemical chair of that Institution. He replaced Baron Thenard in the chair of Analytical Chemistry at the College de France, which professorship he held for several years. In 1833 he was appointed assayer to the Paris Mint, and in 1839 was elected a member of the Institute of France. He subsequently became president of the Commission des Monnaies, an appointment corresponding to our mastership of the Mint, in which capacity he effected many monetary changes, of which not only France but Great Britain has reaped some of the benefits, more especially in relation to the introduction of bronze coinage. For the last twenty years he was a member of the Municipal Board of Paris, and for a considerable period a director of the Establishment of St. Gobain. So varied and important were the results of his labours, that organic, inorganic, and industrial chemistry all received numerous contributions from him, and there is scarcely a branch of chemical science with which his name is not associated. In conjunction with M. Fremy he published one of the most complete works on chemistry extant, a new edition of which was completed shortly before his death. Few men have stood higher in the estimation of the scientific world, and none have been more respected in private life than M. Pelouze. The esteem in which he was held was testified by the large attendance at his interment in the cemetery of Montmartre. On that occasion M. Fremy and M. Dumas delivered funeral orations, the former concluding thus:—"Permit one who has been the pupil and the fellow labourer of the eminent man whom we have lost, to render a final tribute to his memory, and to bid him a last farewell. It is high praise of a man's character and heart to say he knew how to make himself loved—this precious gift was never possessed by any one in a higher degree than by M. Pelouze." It may be added, that such was the invariable hospitality and kindness shown to English scientific men during their sojourn in Paris by M. Pelouze and his amiable consort, that they had acquired the designation of "les amis des Anglais."

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

BRITISH ASSOCIATION MEETING AT DUNDEE.

The Duke of Buccleuch as President of the British Association at Dundee, delivered a short extemporaneous address, which, however, does not possess sufficient interest to require our giving it *in extenso*, as we have done with previous presidential addresses; and therefore after pointing out that the Duke is at one with a continually increasing section of the nation in thinking it of great importance that the elements of science should be taught in our schools, and that a university cannot be considered to perform its duty until it undertakes to teach natural and physical science, we will pass to the speech of Professor Phillips, who, it will be remembered, was president at the Birmingham meeting, whose words have rung again and again in the hearts and pursuits of men of science throughout the length and breadth of Europe.

Professor Phillips then rose and said—Ladies and gentlemen of the British Association, when last year at Nottingham we resolved to accept the invitation of Dundee, we were well aware of what would await us on our arrival here. First, we were aware that we should be received with that hearty hospitality which I trust never will depart from this mountain country of the north. Next, we were well aware that we should be received by a large and intelligent population, who would take a real and lively share in the proceedings of our meetings. We knew well enough that the country of Brewster and Forbes, and Thomson and Rankine—the country of Hutton and Playfair, and Jamieson and M'Culloch—would not only receive us with pleasure, but would contribute its full share of information to the proceedings of the assembly. I am happy to hear from those who are in authority that this particular expectation is likely to be very fully borne out, and that the Scotch communications to this meeting will be such as will be of the highest value, and will be interesting to all those who have now attended from so great distances—from the other ends of the kingdom. I am happy, also, that on this occasion we have, to represent the feeling of Scotland, a gentleman whose name is historic, and whose feeling is national—one who looks with no jealous and envious eye on any particular portion of our proceedings, but with a wise and statesman-like acquaintance with the purposes, the achievements, and the benefits of science, gives us his prudent advice as to how we should continue our labours, and make them more valuable than they have ever been. Most thankful ought we to be to have so full and clear an expression of the opinion of this British Association, namely, that it is not exclusive, but that it embraces all honest opinion touching the works of nature, having no fear whatever of the results which must happen from the investigation of those great works in a pure and reverent spirit; but welcoming heartily and resolutely all attempts to advance our knowledge of nature in every direction, believing that it must be for the good of society and the honour of the Divine Creator. Well, now, it is often said that the proceedings of the British Association have been manifested, as to earnestness at least, by the ample appropriation of large funds devoted to the purposes of the body. It has been often said that many of our speculations and enterprises have no immediate practical bearing upon the useful purposes of life; that if they answer questions, they are questions of a high and speculative interest, not a study for the great mass of mankind, but only for the delight of philosophers living in their cabinets, and who have no share in the public business of life. Well, to that the answer is this, that there is no practical department in which our country is interested which has not been really advanced by the work of the members of the British Association, prompted, and in many cases aided, by the ample contributions of funds which have been contributed by meetings like this. No other fund has the British Association than the voluntary contributions of members who attend these meetings; and yet, too, these contributions have been enough, in the course of thirty-six years, to allow us to expend 60,000*l.*, not wastefully, not rashly, not heedlessly, not in idle speculation, not, my Lord Duke (turning to the noble chairman), in looking for coal, not in seeking for gold, not in any kind of strange fancies that may be thought of no great use in practical life. No; they have been spent in the determination of sound principles, by means of which mechanics have been improved, chemistry has been advanced, navigation has been amended, and all other things have improved on which the progress of human society depends. It may be said, "How are we to be benefited by gazing on those distant objects in space, of which we seem to know nothing except the light which comes from them?" Well, if we gain from that nothing more than this, a right conception of the magnitude of creation; if we know nothing more than that the thousands of stars which stud the celestial spaces obey the same laws which govern this earth and the planets that circle around the sun; if we learn nothing more than this, that the constitution of nature has a law and a generality that runs through the most distant parts of the universe that we can trace; is not that a proposition worthy of the contemplation of intellectual men? Now, it is only by research of the abstract character that we often encourage that those things can be known. How else could you have the information which you will receive within a few evenings from Alexander Herschel touching the discoveries that have been made as to these seemingly irregular flights of meteoric stars, as they are called, shooting through the heavens in this way and that way; these flights that have now been registered for many years, and of which each of our annual volumes contains most important ascertained data? In no other way than by the most abstract reasoning could we acquire any knowledge of that subject. What has happened within this very year? Are you not aware that within the last year of the Association the seemingly irregular flight of the November meteors has been strictly reduced to law, and that among men who have advanced the knowledge of that subject we have the distinguished successor of the glorious name of Herschel, and our own celebrated Adams finishing the inquiry, and ascertaining the exact orbit to be of thirty-three years' duration? Still, it may be said, of what use to us is the knowledge of these meteoric objects? Of what use to us is the

knowledge of the constitution of the distant small planets and little meteorites that occasionally fall upon the earth? and of what use to us is the knowledge of their history? Well, it is of this use at least—it affords an example of the application of the highest and most curious scientific research. What think you of this? A stone falls from the heavens, and you see it is a mass of iron for the most part, and you wish to know something of its history. Well, you trace its history probably by the aid of abstract mathematics. But you trace it in another way, and you go to the Master of the Mint, Sir Thomas Graham, and he analyzes this stone, and he finds in it a most curious thing. You all know probably that metals of a particular kind, when greatly heated, absorb gases of various kinds according to their natures and according to the exposure you give to them. Some of these metals—like silver, for instance—in the course of their being melted and refined absorb oxygen, and give it out when they become cold, though not the whole of it. Others absorb hydrogen, and amongst these iron is a remarkable example. It absorbs an uncommon quantity of hydrogen when it gets gases, but not in the common form of coal iron which comes from your furnaces. I am now speaking on the authority of my friend Dr. Odling, and I know that he is a good authority, and his statement is that in the case of a piece of iron which you take in your hand, the mass of iron which you hold contains within its substance a great mass of gas, though in a particular condition. If it were expanded into space, it would occupy several times the bulk of the mass of iron you hold in your hand. Well. when these experiments have been made you see how much hydrogen is absorbed by the iron when it is in the position I have referred to. Then, a meteoric stone which descended hundreds of years ago contains within its substance gases which it had absorbed in some earlier stage of its history. That gas has been examined and extracted from the stone; it is hydrogen gas, and it shows to you that that stone, when heated and in a former part of its history, had passed through a zone of hydrogen gas. It may have lived in a zone of hydrogen for some time. It absorbed it, and never delivered it out till the present day. Sir Thomas Graham inspected it, and has shown that that is the result. Now, observe how this fits with Huggins' beautiful experiments of the far distant nebulæ, and other objects in the heavens. You know that amongst them the volume of hydrogen has been recognized, and some of you have had the pleasure of seeing a flaming star, which has been visible during the course of the last twelve months. I feel that I am speaking, ladies and gentlemen, as one who enters strongly into the large generous sentiments of our President on this occasion. I am producing these few remarks to you to show that the men of this day are not inactive. I am producing to you the proofs of that great man we have lost. We shall never cease to regret his death. Nevertheless, our duty is to supplement as well as we can the kind of work he was engaged in. We shall not have again a man to explain to us the condensation of gases into liquids. We shall not again have a man to change the magnetic force into the electrical current, and make it do the work of electricity. We shall not again have a man who caused the magnet to radiate in the manner Faraday did. We shall not again have a man who taught us to believe that throughout all nature runs a susceptibility, at least, for magnetic force; but I trust we shall have some future Wheatstones who will know what to do with the discoveries of Faraday, and the discoveries that we may yet receive; and carry further those proofs of the advantages of abstract researches for the advancement of practical knowledge. One word more, ladies and gentlemen. I stand before you as a special friend and colleague of Sir Roderick Murchison. This might be a reason with some, I may say with almost every person but myself, for not saying a syllable on geology; it is no reason with me, who have worked with him almost all my life, and who know the broad generous views which he takes on all general subjects. Therefore, let me say one word with respect to another lecture which you will hear on this occasion—I mean the lecture on the Geology of Scotland—and especially upon the explanation which it will afford of your mountain scenery, lakes, and rivers—which will be delivered by Mr. Archibald Geikie. At any rate, our noble President has shown us that geology is no mere abstract science. Mr. Geikie will show you that it is capable of ministering to the purest and most delicate enjoyment which can affect the human mind in the contemplation of nature. The address I shall not presume to anticipate by any further remarks than such as I have made. Mr. Geikie will show you the cause which has produced your mountains; he will show you the cause which has occasioned your varied and magnificent line of sea coast; he will show you the reason of the great hollows which mark your country; he will show you the principal causes which have been in action in producing every beautiful stream and water-fall. These then, are the objects of the British Association. They embrace the highest current of research that man can enter upon in the works of nature, for we can enter upon the research of everything which will be for the benefit of man, and also for the honour of God. If I further show you that we produce good practical results, and that we minister practically to the wants and enjoyment of mankind, surely I have done enough to commend this meeting of the Association to your favourable consideration.

SECTION G. MECHANICS.—W. J. Macquorn Rankine, F.R.S., President.

The President of the Section, in opening the proceedings, said it was well known that the most important part of the proceedings at the annual meetings consisted in receiving reports of scientific researches made during the previous year, and planning those to be made during the ensuing year, whether by observation and experiment, or by collecting and arranging existing information. The proposals for such researches originated in the committees of the several sections, were then considered by the committee of recommendation, and were finally sanctioned by the general committee; and the reports of them were read to the sections with whom the proposals originated. He thought it might be useful, on the present occasion, to lay before the meeting a brief summary of the researches which had been made or recorded at the instance of the mechanical section since 1850. As that was the year in which he became a member of the Association, he would refrain from extending the summary to earlier years; because that duty could be better performed by some member who had taken part in the proceedings of those years.

Strength of Materials.—This subject had received, as its importance deserved, a large share of the attention of the section. The following were the reports which the section had received, and the dates of the meetings at which they had been read:—

1. Mechanical Properties of Metals as derived from Frequent Meltings, 1853.
2. Tensile Strength of Wrought Iron at Different Temperatures, 1856.
3. Resistance of Iron Tubes to Collapse, 1857, 1858.
4. Resistance of Glass Globes and Cylinders to Collapse, 1858.
5. Effect of Vibratory Action and Long-continued Changes of Load on Wrought-iron Girders, 1860, 1861.

These five reports were the work of Dr. Fairbairn, and they contained the solutions of questions of the highest importance, practical as well as scientific. The third of them, in particular, contained the discovery of a new law in the strength of materials; that which connects the resistance of a flue to collapse with its thickness, diameter, and length, and the correct application of which is essential to the safety of steam boilers. The fifth of them contained the first determination, with any approach to precision, of the *factor of safety* in engineering structures of wrought iron. (The corresponding factor for cast iron had been determined by the parliamentary commissioners on the application of iron to railway structures.)

6. Adaptation of Suspension Bridges to Railway Trains, 1857, 1858 (by Mr. Vignoles). Along with this report there should be mentioned, as having contributed to the solution of the same question, a paper by Mr. P. W. Barlow, read in 1860.
7. Strains in the Interior of Beams, 1862 (by the Astronomer Royal).
8. Strength of Materials in Iron Shipbuilding, 1865 (by Dr. Fairbairn).

Next followed a series of reports of very high interest, relating to the application of materials to the art of national defence.

9. Durability and Efficiency of Artillery, 1855 (a provisional report by a committee, containing suggestions for researches).
10. Resistance of Iron Plates to Pressure and Impact, 1861 (by Dr. Fairbairn).
11. Mechanical Properties of Iron Projectiles at High Velocities, 1862 (by Dr. Fairbairn).
12. Rifled Guns and Projectiles, 1862 (by Mr. Aston).
13. Penetration of Armour Plates and Iron-clad Ships, 1866 (by Captain Noble).

It was unnecessary to enlarge upon the value and interest of the results recorded in the last mentioned report, which must be fresh in the recollection of the members, having been read at Nottingham and printed in the latest volume of reports. They constituted the greatest step in advance which had hitherto been made towards accurate knowledge of the quantity of work required in order to pierce a given target with a given projectile, and the quantity of powder required in order to do that work.

14. Mechanical Properties of the Atlantic Telegraph Cable, 1864 (by Dr. Fairbairn).

Motive Power.—The obtaining of motive power by means of steam had to a great extent been considered in connection with the propulsion of vessels, and came under the head of steam navigation, which would be mentioned further on. The following were the reports relating specially to motive power:—

1. On the Vortex Water Wheel, 1852 (by Professor James Thomson).
2. On Water-pressure Machinery, 1854 (by Sir W. G. Armstrong). Two reports containing valuable information as to two classes of hydraulic prime movers.
3. On the Density of Steam, 1859, 1860 (by Dr. Fairbairn and Mr. Tate). These communications had not been printed amongst the reports, but only in the proceedings of this section, being merely abstracts of researches which appeared in detail in the "Philosophical Transactions," but the importance of the results contained in them made it necessary to refer to them now. Those results constituted the first direct determinations of the density of steam, and besides their practical value, they furnished a most remarkable confirmation of the dynamical theory of heat.
4. Steam-Boiler Explosions, 1863 (by the Astronomer Royal), showing the great explosive energy possessed by a mass of liquid water at a high temperature.

The President here observed that it had been established beyond a doubt, according to the second law of Thermodynamics, that the utmost quantity of work which can be got by the expenditure of a given quantity of heat depends solely on the limits of temperature between which the engine works, and is independent of the nature of the fluid to which the heat is applied, such as water, ether, air, &c. The means of improving the economy of heat in thermodynamic engines are of three kinds:—First, working expansively so as to obtain from the heat applied to the fluid all the work that is possible between given limits of temperature; this has probably been already carried to the utmost extent practicable. Secondly, increasing the range between those limits of temperature; to this there are bounds set in practice by the conditions of durability and safety; and Thirdly, diminishing the quantity of heat which goes to waste from the furnace. The last is probably the means which at present holds out the greatest probability of improving upon the economy of the most economical steam engines of the present time. It is probable that the use of rock-oil as fuel may contribute towards that result; and something may perhaps be hoped from the direct use of the products of combustion to drive the engine.

5. Gun Cotton, 1863–64–65. In these reports by a committee, it is shown how gun cotton is adapted to various purposes by suitable mechanical preparation.

Hydraulic Engineering.—1. On the Water-supply of Towns, 1855 (by Mr. Bateman). A Report of great interest, on a subject worthy of the continued attention of the Association.

2. On Rainfall, 1864–65–66. A series of reports by a committee, based chiefly on observations collected by Mr. Symons. These will probably be continued annually.
3. On Weir-board Gauges, 1856, 1858, 1860–61 (by Professor James Thomson). Reports containing the results of experiments on the gauging of the flow of water in streams by means of "notch-boards," showing how accuracy is to be insured in such gauging; and in particular, the properties and advantages of triangular or V-shaped notches.
4. Tides in the Trent and Humber, 1864 (by Mr. Oldham).

Shipbuilding and Steam-Navigation.—1. The Strength of Materials in Iron Shipbuilding, and the Resistance of Armour-plated Ships to Penetration were referred to under another head.

2. Tonnage of Ships, 1856–57 (by a committee).
3. Steam Navigation at the Port of Hull, 1853, 1859, 1861 (by Mr. Oldham).
4. Iron Shipbuilding on the Tyne, Wear, and Tees, 1863 (by Mr. Palmer).

The three preceding subjects partake of a statistical as well as a mechanical character.

5. Life-boats, 1854 (by General Chesney).

6. Statistics of Life-boats and Fishing-boats, 1857 (by Mr. Henderson).

7. River Steamers, 1858 (by Mr. Henderson).

8. Mercantile Steam Transport Economy, 1856-57, 1859, 1861 (by Mr. Atherton).

9. Shipping Statistics, 1858 (by Admiral Moorsom).

10. Resistance of Water to Floating and Immersed Bodies, 1865–66 (report of experiments by a committee).

11. Steam-ship Performance, 1857, 1858, 1859, 1860, 1861, 1862, 1863.

A series of reports of data collected from various quarters by a committee, presided over at first by the late Admiral Moorsom, and afterwards by his Grace the Duke of Sutherland.

Referring more especially to this last-mentioned series of reports (and also to the reports of the experiments of Mr. Scott Russell on waves, published previously to the period to which this summary is limited), it may be held that the reports and archives of the British Association contain perhaps the greatest mass of data of experiment and practice ever brought together for the purpose of improving the science of the designing and propulsion of vessels. The bulk of that mass of information is so great, that it was advisable to appoint a committee last year for the purpose of condensing it; and a report by that committee will be laid before this meeting.

The use of the jet-propeller has lately been revived and extended; and in future reports it is highly desirable that examples of its performance should be recorded.

Conveyance.—1. Railway Brakes, 1859 (by Dr. Fairbairn).

2. Sound Signals at Sea, 1861 (by Professor Hennessy).

3. Fog Signals, 1863, 1866 (by a committee).

All these reports contain results of great importance to the public safety.

The attention of the Association was called last year to Mr. Fell's method of ascending steep gradients on railways by the help of a central rail. That invention appears to have been perfectly successful.

Metallurgy.—The President said that although no report upon metallurgy had been presented to this section within the period to which this summary referred, he considered it essential to its completeness to mention his ordinary communications to the section, in 1856 and 1865, by Mr. Bessemer, on his method of making iron and steel; a subject to which the section might well devote a large share of their attention.

Agricultural Machinery.—No report on this subject had ever been laid before the section; but an ordinary paper had been read in 1853 on the history of reaping machines by Mr. Crosskill. The inventor of the first practically successful reaping machine, the Reverend Patrick Bell, resided at no great distance from Dundee; and he hoped that the meeting would, if possible, be favoured with the presence of so great a benefactor to agriculture.

Reports had been made on the following subjects at the instance of the Mechanical Section in conjunction with various other sections of the Association.

Weights and Measures, 1864–65–66.

Patent Laws, 1858–59, 1861.

Scientific Evidence in Courts of Law, 1866.

AERONAUTICAL SOCIETY OF GREAT BRITAIN.

(*Continued from page* 189.)

Mr. Wenham, irrespective of the mode of propulsion just proposed, considered that the form of aeroplane is not that which will give a good sustaining effect for want of lateral extension. It is not perhaps generally known that Henson's machine was actually constructed. He thought the two planes were in length about three times the breadth; when the machine was launched from an altitude, for want of greater length of wing, it descended only a short distance from the starting point. He believed that the whole question of aerial support and propulsion is simply based upon the laws of action and reaction of relative weights, or that of a body supported impinging upon a great weight of air. As it has been inferred that a body set free in air and ever about to fall may be continuously supported by the constant action of a small force, he would venture to quote the familiar example of a ball kept aloft by a fountain. To keep a body weighing 100 lbs. sustained on a jet of water of 1 square inch in section, the water must issue at a speed of 76 feet per second; this represents a force of 13·81 horse-power. If now we increase the size of the jet to 10 square inches to support that same weight, the water pressure will be reduced to $\frac{1}{10}$, and the velocity of the fluid will be 24 feet per second, and the power represented by 4·36 horse-power. We have here the same mechanical condition performed in the second case, with the expenditure about one-third of the power required in the former. In fact when the total pressure is the same, the economy is in direct proportion to the relative speed of the issuing current throughout the scale downwards. He had before stated that the yielding of the abutment, either for sustaining or propelling heavy bodies in air or water, known as "slip," taken as a direct per centage, is just equivalent to as much mechanical effort lost upon the weight supported or moved forward. It has been shown by experiment that a small jet of water issuing at a very high velocity is inadequate for propelling a steam vessel. As the size of the jet is increased and its velocity diminished, so do we obtain a better result. It would appear then conclusively that for the so-called principle of jet propulsion (which, in fact, like any other principle of fluid propulsion, is merely action and reaction of force between two relative weights) the most favourable condition would be as large a body of water as possible, acted upon in the direction nearest approaching to the vessel's course, without either turns or deflections; and that this is best to be arrived at, not by any paradoxical form of centrifugal pump, but by the direct action of a screw contained in the water channel; and the same reasoning will apply to similar proposals for aerial propulsion made to this society. He here assumed that the screw is inclosed in an open-ended case; but if there is plenty of clear space in front the screw will act as well or better without being so inclosed, and therefore, in spite of the costly experiments that have recently been made to revive the system of jet propulsion, it was clear to him that the screw-propeller must be much superior.

Mr. F. W. Brearey read the following communication from Mr. John Frederick Bourne, member of the Institute of Civil Engineers:—"I have read with much interest the first annual report of your society for 1866. It has occurred to me that it may be interesting to you to have an account of some experiments made many years ago in South America. I happened, in 1843, to be at the house of my friend James Frazer, Esq., M.D., Edinburgh, Hoff van Aurich house, Essequibo, British Guinea, when he received his English papers, one of which gave a description and representation of Henson's flying machine. Dr. Frazer, who is now residing in Scotland, is a man devoted to science, and an exceedingly skilful mechanic. When we had read the description, he said to me, 'That will never do, Bourne; this is the way to fly;' and taking up and opening an umbrella, he held it vertically and screwed it round: 'We must *screw* ourselves up. There's an idea for you; now you can carry it out and make a model.' I asked him for a watch spring, which he found in his workshop and gave to me. I made the first model with only one set of four wings stuck into a piece of cork, like the sails of a windmill; each wing being a large fowl's feather. The cork was stuck on to the top of a stick of white pine, small enough to pass freely through a quill, and about 12 inches long. At about a couple of inches from the bottom of the stick a pin was pushed through till only the head projected sufficiently to allow the hole in the inner end of a watch spring to be hooked over it; the point end of the pin was then cut off flush with the stick. A second piece of cork, rather larger than the first, had a short portion of the tube of a quill pushed through its centre, and to the circumference of it a piece of stick was lashed securely, to which the outer end of the watch spring was tied, when the stick or vertical shaft had been put into its place in the quill as its bearing. Into the under part of this lower cork two large feathers or tails were stuck, projecting downwards, to act as fulcra for the watch spring. To wind it up I held the vertical shaft in the left hand, and with the right hand gave the bottom cork and the two tails a half turn, letting one tail rest upon my shoulder or chest till I had got my fingers ready for another half turn, and so on till the spring was wound up. On letting it go it shot up with force to the ceiling, and on trying it out of doors it went considerably higher. On showing it to Dr. Frazer, he clapped his hands and said, 'That's it; the *principle* is proved.' I then made a second model, with the same spring, but with the following points of difference. Instead of feathers for the wings I used strips of bamboo, with cartridge paper clothing pasted on, like the little windmills used by children to run against the wind, but with long narrow wings instead of the half round pieces of paper used by children; and instead of the two tails stuck into the bottom cork, I put four more sails or wings of the same size and description as the upper ones, but 'set' in the opposite direction, so that if the upper stratum of four wings formed a right-handed screw, the lower stratum of four other wings formed a left-handed screw. This model, though perhaps twice as large as the other, and with only the same spring power, went up to about twice the height of the first. It shot up to the height of the eaves of the house, about 20 feet. I weighed the model, but forget the weight now; it was between one and two ounces. I believe I still have somewhere in my possession one or two of the wings, and perhaps the spring, as I saw them at the Cape of Good Hope when packing up lately to come home.

"It seems to me that what is required first of all is a very light motive power bearing the same (or even a rather greater) proportion to weight to that of the rest of the apparatus and fuel, or other supply, that my watch spring did to the model. It would be sufficient for the machine to rise but slowly from the ground, and not to shoot up as mine did. The common black vulture of South America rises with great difficulty, but once arrived at the required height, seems merely to float on the air without the least exertion. I have timed one which alighted near a spot about 6 miles from where I stood, and which did the distance in about six minutes without any apparent motion of the wings. I have sometimes thought that a boiler of small and thin tubes, using spirits both as the expansive fluid, and after it has done its work also as fuel, might possibly answer; and a friend of mine at the Cape, the Hon. Mr. Griffith, attorney-general, has suggested to me that attention should be paid to some of the new metals to secure at the same time lightness and tenacity, or as near an approach to the substance of the quill as possible. My heavier model ascended higher than the lighter one with the same power, and I agree with Dr. Frazer in thinking that when we obtain the right motive power, the rest of the machine may be made of light metal tubes, wire, and very thin metallic sheets, without wood, silk, or other bulky material. The steering will easily be effected, by an easy displacement of the centre of gravity of the whole machine through a universal joint, placed between the working apparatus and the car. In rising perpendicularly the centre of gravity will be in the same vertical line with the working shaft. To advance in any direction it will only be necessary to throw the weight of the car, by suitable steering gear, towards that direction; this will throw the wing planes towards the same direction, and the diagonal force thus obtained will be resolved into a perpendicular to prevent descent, and a horizontal to advance to the required spot. And the speed of the advance will, of course, be plus or minus that of the wind, as it may be favourable or otherwise. You will be pleased to observe that my experiments tend to show the theory of Mr. Wenham to be correct with reference to a series of superposed planes of wings acting on different planes of air; but I cannot agree with him in his theory of the slip of screws in air, as laid down in pp. 24–25 of your published transactions. It reminds one of the old theories of the slip of driving wheels of locomotives on the rails, and the patents that were taken out for legs, cogged rails or wheels to prevent this slip, or obviate it. I cannot see why a wing travelling in a curved line, in a constantly new stratum of air, should have more "slip" than if it moved in a straight line. I would only say *try it;* not in the way specified in pp. 22–23, but in a machine *free to move into new strata.* The experiment with the steamboat, p. 20, is analogous; very little would hold it, but "let her go," and the difficulty vanishes. And all mechanical locomotion is best effected by propellers moving with a circular, and not a reciprocating motion.

Mr. A. Stewart Harrison read an extract from a tale he had published in *Once a Week* some time since. He had put the words into the mouth of a madman, who was supposed to have been speaking some fifty or sixty years since, and it was

singular that the ideas thus expressed were precisely those which appeared in the paper just read. Now he thought, speaking seriously and not as a madman, that it would be just as reasonable to study the elaborate anatomy of a duck's foot, for the purpose of attaining the best mode of propulsion on the surface of the water, as it would be the motion of a bird's flight for modelling a flying machine upon the plan of its wings. He apprehended that if any gentleman could place in that room a steam engine, or other engine, of one horse-power, which would only weigh 20 lbs., means could easily be devised by which heavy bodies could be moved through the air. He thought it was entirely wrong to found their proceedings upon an imitation of the flight of birds, and that but little success could flow from it. The backward stroke of the bird's wing was undoubtedly a waste of power, and nature had provided the bird with a most delicate apparatus of sensation, which enabled it to diminish that waste as much as possible. He was convinced it was the upward and forward stroke which effected the work, and that therefore the continuous motion of a rotary wheel was the best means of effective flight.

The Chairman thought that the preceding speaker had to some extent mistaken the object which the society set before itself in studying the flight of birds. It might be quite possible that ultimately they would not imitate the structure of the bird's wing, any more than that in respect to propelling the *Great Eastern* through the water they had imitated the structure of the duck's foot; but what they wanted to ascertain was, the exact mechanical principles upon which the flight of the bird depended; such as the relation of velocity of flight to the strength and weight of the bird, and the shape and size of its wings. The same mechanical principles would apply in all cases, and at present we were lamentably ignorant of the laws of flight.

Mr. Hurry fancied that the stroke of a bird's wing was propulsive in the upward as well as in the downward stroke, and that unless this were so, a sort of impulsive or jerking motion would be observed to result from each downward stroke, which would be absent from the upward stroke; but instead of that, the bird appeared to float along in one continuous even course. He apprehended that the reason of the running motion of the bird in the earlier part of its flight was that it could not get at first a plane surface of air for the whole of its wing. Since reading Mr. Wenham's paper he had taken considerable pains to watch the flight of birds, and he had noticed that where the bird started from a height, as from the twig of a tree, where it would be in the middle of a soar, so to speak, no exertion whatever was apparent. The effort of starting from the ground arose from the necessity of getting the wing sufficiently horizontal; some birds, indeed, such as swallows, could hardly rise from the ground at all, and they invariably ran to a little mound, or anything raised above the level of the land, before commencing their flight. As to the application of the screw, he thought it should be in the line of the supporting plane, as being that in which the least amount of force was required for sustaining weight. He believed that the screw would be found to be effective as a means of attaining propulsion, and if a motive power could be obtained which would only weigh 20 lbs. to each horse-power, the thing might be considered as accomplished, as great power was not wanted so much as great velocity of motion.

Mr. Oliver Byrne thought that the vacuum created by the rush of the bird through the air had something to do with sustaining its flight, and he instanced the flight of bullets, where it was found that by giving them sharply cut rims, greater velocity was attained.

Mr. E. W. Young remarked that there was no loss of power during the up stroke of the wing; that the bird propelled itself by the down stroke, and by altering the angle of its wing it supported itself during the up stroke; that the air always impinged upon the under side of the wing. He also suggested that for trying experiments in the art of flying, the safest way would be to fly the aeronaut and his machine on a windy day as you would a kite, then if the propelling power possessed by the machine was sufficient to slacken the cord by which the machine was held against the wind, the problem would be solved, and aerial navigation an accomplished fact. He suggested that a post, 10 or 12 feet high should be driven into the ground, and the cord by which the machine was to be restrained attached to its upper extremity; thus it could be managed that the aeronaut should be sustained by a *horizontal* pull, and the downward pull which an ordinary kite experiences avoided. He stated, moreover, that the flight of birds was still an enigma to him; that he could not account for the great ease with which their motions were accomplished; that the ordinary theory of the action of the wind seemed to show that mechanical flight by man was impossible. For instance, if we supposed a plane one foot wide, inclined at a slope of one in ten, driven against the air at a rate of 35 miles per hour, we should apparently get the following result, a sustaining force of ·12 lb. per square foot of the plane, and a horizontal force of ·012 lb. for the same. Tables show that a velocity of wind equal to 35 miles per hour gives a pressure of about 6 lbs. per square foot; the plane being inclined at a slope of one in ten, would present a vertical surface of one-tenth of a square foot, receiving a total horizontal pressure of ·6 lb.; resolving this by the parallelogram of forces, we get a vertical force of one-fifth, or ·12 lb., and a horizontal resisting force of ·012 lb. This angle of wing was too great for practical purposes, for a continuous pressure would have to be exerted equal to one-tenth of the weight supported. To show the difficulties of the problem, he supposed a case in which the slope of the plane was one in twenty only, and that a sustaining force of $\frac{1}{2}$ lb. per square foot could be obtained with such a low velocity as 30 miles per hour. He assumed the aeronaut and his machine to weigh 200 lbs., that 400 square feet at least of wing were required; then if the resistance of the air to the man's body and working parts of the machine were neglected, a continuous horizontal pressure of one-twentieth or 10 lbs. would be needed to sustain the machine. Now 30 miles an hour is 44 feet per second, and a pressure of 10 lbs. exerted through a distance of 44 feet equals 440 foot-pounds, or units of work per second, which is more than any man could accomplish. He suggested the advisability of trying some experiments on the sustaining force of the wind when acting against an inclined surface, which he believed would be found to be much greater than was commonly supposed.

Mr. Wenham thought that part of the investigation should be directed to measuring the force afforded by the currents of air, but in England this would be almost impracticable, owing to the diversity of the currents; he proposed shortly to try a series of experiments by the aid of an artificial current of air of known strength, and to place the society in possession of the results, as he thought that at present a great deal of time and labour was being lost and misapplied as a consequence of ignorance on points of this kind.

Mr. Henri Reda St. Martin read the following paper on

A NOVEL APPARATUS FOR AERIAL LOCOMOTION.

It may be remembered that at the last meeting of this society I described a project for aerial locomotion, based mainly upon the same general laws and actuating elements that support and influence the movements of the kite. The peculiar novelty of this project, the novelty which in fact nearly absorbs the whole idea, was accepted by most of those present at the meeting as founded upon reasonable data, and in some measure upon actual experiment. I say actual experiment, because a pleasing reminiscence of our childish sports is no doubt cherished in the memory of most of us, and therefore the movements of the kite must come within the range of our own personal experience. We are all aware that the kite is maintained in the air by what may be termed an opposition of two forces—the impelling power of the wind, and the restraining power of the string, at one end of which the kite floats. The former, or impelling force, is an ever present and always effective existence; the latter, or restraining power, is an artificiality, subject to innumerable modifications and conditions. The desired result produced by the combined action of these forces in the case of the kite is no proof, it may be said, that a conjunction of power apparently similar would be equally successful under other conditions. But the results furnished by the kite prove at least the feasibility of my project, for they elevate it above the rank of a mere supposition, and plant it upon substantial and practical data—data with which we are all more or less acquainted. My apparatus may, therefore, claim a motive power in the wind, and at least the basis of a restraining power, such as we see in a certain phase exemplified by the kite. It appears to me, then, that the chief, if not the sole question which remains and claims attention is: Have I discovered a restraining power that will act as effec tively as the string in the case of the kite?

I endeavoured on a former occasion to describe an apparatus which I propose to apply as a restraining and regulating agent for the support and guidance of a surface or sail, sufficiently extensive to represent a power capable of raising and supporting a single person in the air. As I am now able to present to the meeting a small model of my apparatus, I need not recapitulate any part of that description. But it should be distinctly understood that I do not offer this model as a perfect representation of my apparatus, still less as a working model. It simply stands in the place of a less evident verbal description. In this apparatus the screws represent the restraining and regulating power. It will probably be recollected that I described these screws as moving in a direction contrary to that in which they usually act. They serve to check the inclination of the sail to follow the course towards which it is otherwise urged; they do not propel in the line of the intended flight, but exert a force in some measure contrary to that direction, and thus tend to sustain and balance the whole apparatus in the atmosphere. This supposition appeared to receive the general concurrence of the meeting. The doubt was not as to the tendency of the power exerted, but as to the probability of concentrating and applying within certain necessarily prescribed limits a sufficiently efficacious restraining power. Towards dispelling this doubt I am now enabled to place before the meeting a few calculations, which, though not assuming the place of ultimate facts, may nevertheless presume to challenge a sufficiently satisfactory result. The combined weight of the aeronaut and the apparatus I estimate at about 400 lbs.; and as a sustaining surface, I have calculated that the sail or plane should measure about 300 square feet. These figures are rather in excess of what I think will be demonstrated in practice. We will now suppose that this plane assume an inclination of 45°, and that the wind impinges against it at a velocity of about 21 feet in a second, which is equivalent to a pressure of one pound on every square foot. That this sail with its accompaniments may under such circumstances be sustained and equilibrated in the atmosphere, a power represented by about 300 lbs. will probably suffice.

The query then presents itself—Will screws of practicable size and weight be sufficiently effective to supply this power? A practical essay alone can furnish the ultimate answer to this query; but I am disposed to believe, after careful calculation, that we shall not be far out if we assume that two screws, having a diameter of about 8 feet, and affording a working surface of about 50 square feet, and rotating at a velocity of about three revolutions a second, will supply an ample sustaining force. Then as to locomotion. I have computed that as the resistance of the air to a surface moving in it is in proportion to the velocity at which the surface travels, a considerable, if not rapid, movement may be attained by an addition of 20 lbs. to the restraining power. I propose to effect this increase by reducing the angle of inclination presented by the sail, and thus relieve it of a certain amount of atmospheric pressure, a movement which would be equivalent to a positive addition of impelling power. This, of course, must be conceded. Yes; but then it will be objected that I have stolen the force necessary to impart this impetus from my sustaining power (a power, by the by, which should somewhat exceed the ability of mere sustentation) I can hardly acknowledge the full justice of this impeachment. I have done no more than borrow a power which a moment after I restore, and before the apparatus can have suffered any appreciable declination. Thus it may be affirmed that with the ability to borrow sufficient force to effect a certain rapidity of locomotion, I want but little more power than what is sufficient to maintain the apparatus in the air in a state of equilibrium. There will, therefore, be two movements subjecting the two components of efficiency in the apparatus not to simultaneous but to successive flowing, or rather undulatory, action. The movement of the head or apex of the sail will be somewhat similar to that of the head of a person in the act of swimming. It is not necessary, however, that any definite time should take place between the intervals of advance, movement under such circumstances being controlled by, and depending upon, a variety of contingencies.

Thus far, then, I think it may be affirmed that we arrive at two favourable results:—First, that the restraining principle, or rather method, is sound both in theory and practice—that if *sufficient* power can be applied, it will be *efficient*; and, secondly, that admitting the possibility, I may say the probability, that the

calculations I have just submitted to you are to some extent, even to a great extent, erroneous, and that the estimated power will fall short of the amount eventually demanded, there must still remain the reassuring and very palpable fact, that my apparatus will be satisfied with a mere fraction of the power demanded by every scheme hitherto projected for aerial travel.

As to the question—In what way is it proposed to propel the apparatus with the wind? I answer, that this is effected in much the same manner as that already described when the course of the wind is *against* the apparatus. In this case the action of the screws is reversed, thereby pushing instead of pulling the sail, thus producing, as in the former case, a restraining and regulating power. But it would be encroaching too much on your time and attention to enter at present upon a discussion to decide what degree of certainty can be shown of obtaining a directive or controlling power. I shall be amply satisfied if my apparatus has so far produced a favourable impression upon the meeting as to establish the conviction that in it there may be discovered a means, partial to all appearance, and even perhaps in fact, but still a practicable means of gratifying the long-desired human ambition of achieving aerial locomotion.

During the reading of this paper, the Duke of Argyle being called away by other engagements, proposed that Mr. Hurry should take the chair.

Dr. Smyth remarked that every experiment made with the screw propeller showed that it required the expenditure of immense power in order to give it sufficient velocity, and at present no motive power had been discovered light enough to effect it.

Some discussion arose as to the adaptability of the proposed machine, and Mr. St. Martin explained, by means of a beautifully constructed model, the method by which it would be worked.

The Chairman remarked that he could not see in the model the very essential element of progression. The meeting could see the operation of three forces—that gravitation which would be towards the earth; the force of the wind which would be blowing in the face of the person in the car, this would be horizontal; and these two being converted into one would bring the machine downwards and backwards; where then was the means of progression through the air upwards?

Mr. Wenham said, whilst he protested against the screw as being utterly inadequate and useless for raising weights, he at the same time admitted its perfection as a propeller, both in air and water. In air, it need not necessarily be of the large diameter generally supposed, for in a ship propeller the area varies from one-third to one-fifth of the immersed area of the midship section of the vessel, estimated as the entire area of the circle of revolution. In air the screw will not be greater, as the relative conditions of reaction and resistance would be similar in both cases. Until the vessel acquires some speed the screw has considerable slip and very little propelling power; this becomes fully developed with the maximum speed of the vessel.

Mr. A. Stewart Harrison in proposing a vote of thanks to the Duke of Argyle and to his grace's successor in the chair (Mr. Hurry), said he had no doubt the people outside thought it was very desirable that those present should be taken care of by their friends. He did not; but he thought that as gentlemen risked something of their reputation for soundness of judgment by taking the chair when such flighty subjects were discussed, they could not do less than acknowledge their kindness by a vote of thanks.

A very ingenious model upon a large scale, of an aerial machine whose sustaining power was gas, partly assisted by the screw, was exhibited and explained by its maker and designer, Mr. Sadd.

MONTHLY NOTES.

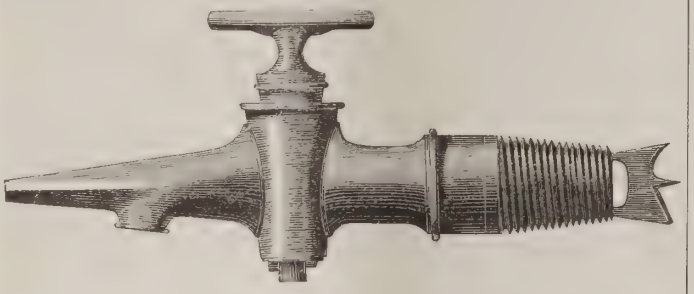
The Vieille-Montagne Zinc Company.—This company was founded in 1837. Its head office is at Angleur, near Liége, and it has branch offices at London, Paris, New York, Cologne, and Brussels. Its business is the working of mines of calamine (carbonate of zinc), and blende (sulphuret of zinc), copper, cobalt, lead, and coal; the manufacture of zinc, and that of zinc white. For these purposes it has no fewer than nine establishments in Belgium, eight in Germany, three in France, and one in Sweden. They employ upwards of 6600 workmen, and their establishments contain eighty-three prime movers, of which sixty-five are steam-engines, and the rest impelled by water. They represent altogether a force of 2394 horses. They annually manufacture 32,000 tons of zinc, which is converted into sheet metal, nails, bars, thread, thin perforated sheets, and zinc white, of which last they make from 5000 to 6000 tons a year, whilst of rolled zinc they turn out about 25,000 tons. The demand for zinc has been gradually increasing for several years past. Its principal application is for the roofing of buildings; and for this purpose it is largely employed in England, France, Belgium, and other parts of the European continent, as well as in America. Zinc is also used for statues and other works of art, which after casting are coated with copper by the galvanic process. Such articles are very much cheaper than those of solid bronze. Zinc white is an oxide of zinc, and is used as a pigment. Since it is whiter, more solid, and cheaper than ceruse, that is, white lead, the use of the latter poisonous agent ought to be everywhere discountenanced in favour of zinc paint, which is perfectly innocuous. Neither does it change colour like white lead under the influence of the sulphuretted emanations so common in towns.

Mr. A. G. Ballantyne and Ground-Batteries.—Mr. A. G. Ballantyne has made a communication to the Franklin Institute of Philadelphia about ground-batteries, in which he argues that the best way to develop electrical science and its applications would be to make free use of the earth as a reservoir of electricity. A battery for generating a permanent current of galvanic electricity, uniform in its action, and of considerable power, can be made by burying in the earth, a few feet below the surface, a sheet of zinc and a sheet of copper, about 8 inches apart, the space between them being filled with the damp earth dug from the hole. An insulated wire attached to each plate will lead the current generated by the action of the two metals to any place where it may be required for use. By a contrivance of this kind, Mr. Ballantyne kept a mechanical figure moving for three years without interruption. Hence other mechanical movements might be devised, and electrotype processes carried on, by the cheap and simple operation of burying a couple of plates as above described. Another way tried by Mr. Ballantyne was to plunge a basket of coke into a pond, and connect it by a copper wire with a buried zinc plate, whereby he produced a current which was employed to excite an electro-magnet during several months. And it may be accepted as a fact, that a permanent ground-battery may be made by burying some 5 or 6 feet deep a zinc plate bent into the form of a tub without a bottom, with a layer of common coke inclosing it within and without, but not in contact. The contact must be made by copper wires carefully insulated, which, when prolonged, will convey the current in any direction. From these practical details, Mr. Ballantyne proceeds to explain that the whole subject of electrical science is much simpler than most people suppose, and that all we have to get thoroughly acquainted with is, that there are but *two currents* that have ever been detected in any electrical, magnetic, or galvanic series, and that these two currents have but two properties—*quantity* and *intensity*. All the terms hitherto used to describe these currents are faulty, but the most faulty are *positive* and *negative*. These two terms, originated in the early days of electrical experiment, will now have to be discarded by men of science, who will probably substitute for them the terms *major* and *minor*. In any case, the ground-battery remains as an available apparatus for various economic purposes, electrotypy, and so forth; while it is perhaps the best that could be adopted to generate currents which are to be applied in the treatment of disease.

Bathometer—An Instrument for measuring the depth of Water without a Line.—It has been found difficult by means of a line to ascertain the true depth of rivers, and other bodies of water in motion, on account of the currents which often cause deviation of the line from perpendicularity; and in sounding deep seas and oceans much time is consumed on account of the retardation of the line by friction, both in ascending and descending. This invention obviates these difficulties, and it consists in general terms in measuring the depth of water by the compression of a fluid or fluids contained in a vessel sunk by a weight, which is automatically detached from the rest of the apparatus on striking bottom, allowing the vessel and its other accompaniments to be raised by a buoy, the apparatus being sunk without any connection with a line, and the buoy being provided with a signal to enable the operator to discover it when it ascends to the surface of the water. In carrying out this invention, take a glass bottle, A B C, say, about five or six inches long, and of such interior diameter that its capacity, exclusive of any solid substance and of the mercury and air it may contain, shall be about five cubic inches; take also a glass meter tube, C D, about seven or eight inches long, open at both ends, with a bore of about one-fifth of an inch in diameter; let this tube be swelled near the upper end and the swelled part ground into a stopper to fill the neck of the bottle; pour into the bottle mercury to a level with the lower orifice of the meter tube and enough more to fill the meter tube once; then fill the bottle with water and insert the meter tube so that the swelled part or ground glass stopper shall be fitted perfectly tight into the neck of the bottle; take then a thin india-rubber tube, E, five or six inches long, and draw it over the outer end of the meter tube and fasten it; fill the rubber tube with water, and fasten it by winding and tying a cord around the tube; it will then form a bag of water, and it should be long enough to hold a quantity of water at least sufficient to fill the meter tube once. A scale is to be adapted to the meter tube. When the instrument is ready for operation the water or lighter fluid will completely fill the meter tube. If the instrument is now sunk in deep water the external pressure of the water as it descends will cause the fluids in the india-rubber bag, the meter tube, and the body of the vessel to contract, and will force the water in the meter tube through the mercury into the body of the vessel to supply the vacancy caused there by the compression of its contents. On the return of the instrument to the surface the expansion of the fluid or fluids in the body of the vessel under the relaxation of the external pressure during the ascent will force the mercury into the meter tube to the amount of their greatest compression, thereby indicating the degree of that compression, and by inference the depth to which the instrument has descended. The instrument is rendered more sensitive and more applicable for measuring depths not exceeding 500 feet by the introduction of a minute quantity of air or other elastic fluid into the vessel containing the liquids. The liquids can easily pass each other in the bore of the meter tube, thereby enabling the operator to restore them to their original position for a new operation merely by turning the instrument. A bag of india-rubber or other suitable flexible material is attached to the outer end of the meter tube for the purpose of preserving the exact quantities of the fluids in the vessel as at first adjusted, and of enabling the operator by pressure upon the bag to discharge the contents of the meter tube into the vessel, and therefore to use a meter tube of small bore. A buoy, F, and weight is attached to the instrument by any suitable self-detaching device, so that when the instrument or its appendage touches the bottom the weight shall be detached and allow the buoy to carry the instrument to the surface, thereby dispensing with a line. The submerged buoy is released by causing a small weight, O, attached to the long arm of lever, H K, to support on the short arm the larger weight, P, which sinks the buoy till the smaller weight by touching the bottom is supported thereon, thus causing the short arm, no longer counterpoised, to fall and discharge the greater weight. A rod or pole, G, is attached to the instrument, so that on its return to the surface of the water it will attract attention at a distance, so as to facilitate the recovery of the apparatus of which it forms a part. The upper end of the rod should be prepared with small pieces of bright tin, polished metal, silvered or coloured glass or other substances which will reflect the light and attract attention from a distance. For greater accuracy in deep-sea soundings the bathometer should be surrounded by melting ice to keep the bottle and its contents at (32 Fahr.) a fixed temperature. The buoy used is of glass, this being about the only material which will resist the

immense pressure of a column of water miles in height, and retain its buoyancy. A glass sphere in the United States patent office has withstood the pressure of seven tons on the square inch. It floats more than half out of water. A B bottle, D mercury, C meter tube, E rubber bag, F glass sphere buoys, G the rod or signal, P the weight which sinks the instrument, O the small weight. The instrument is here represented as rising, the weight having just been discharged.

Bignon's Tap.—The cut shows the form of this tap, which is furnished with a boring bit followed by a screw. This part is made conical, with the view of preventing the escape of the liquid from the cask when it is being screwed in The



other end of the tap projects beyond the orifice, and is made square or diamond-shaped in section, so that the utensil may be worked into the barrel by a hand brace.

Adhesive Paste.—A white paste, adhesive to all surfaces, is said to be made as follows:—A solution of 2½ ounces gum arabic, in two quarts warm water, is thickened to a paste with wheat flour; to this is added a solution of alum and sugar of lead, 720 grains each in water: the mixture is heated and stirred about to boil, and is then cooled. It may be thinned, if necessary, with the gum solution.

New Fibrous Materials.—Much attention is being given in France and elsewhere at present to the preparation of fibres from various indigenous and acclimatized plants. M. C. Peyre, a chemist, of Nancy, is said to have produced fibres from the nettle which closely resemble fine hemp, and unbleached fibres of the olive, which, it is believed, may, when tanned with the gallic acid from the bark of the same tree, become valuable for sail-making. The treatment of the fibres of the mulberry tree was attempted by means of caustic lye, for the removal of the woody and gummy portions; but it was soon found that the alkali ruined the fibre. It is now said that M Peyre has prepared a special solution for the purpose, which has not the same mischievous action, but its composition is not revealed. The result is stated, however, to be the production of a supple and brilliant fibre, closely resembling floss silk. Another chemist, M. Lucien Tracol, of Bourg-Argental, is also busy upon the mulberry fibres, and his experiments are said to hold out good prospects of success.—*Paper Trade Review.*

Patents.—The Lord Chancellor, the Master of the Rolls, and the late and the present Attorney General (the latter then Solicitor General) as commissioners of patents, report that 2124 patents were passed in the year 1866. The amount received in the year for stamp duties, the fees being now paid by means of stamps, was 114,461*l.*, which was more than double the expenditure of the department: 9428*l.* was paid in fees to the Attorney General and the Solicitor General, and 856*l.* to their clerks. The receipts include 31,400*l.* for continuing old patents beyond the first three years of their term of fourteen years, and 21,900*l.* for continuing old patents beyond the first seven years of their term. The fee of 50*l.* for continuing a patent beyond its third year is paid on about 30 per cent. of the patents issued, and the other 70 per cent. become void at the end of three years. The further sum of 100*l.* payable at the end of the seventh year is paid on about 10 per cent. of the patents issued, so that 90 per cent. are allowed to become void at the end of the seventh year. The commissioners continue their work of publishing abstracts or abridgments of all specifications from the earliest enrolled to the present time; they are issued in classes and chronologically arranged, sold at the mere cost of printing and paper, and presented to the authorities of every important town in the kingdom on condition that they shall be accessible to the public daily, free of all charge. The new classes in course of preparation relate to fuel, steam engines, railways, railway signals, hydraulics, ventilation, rolling stock, raising, &c., heavy bodies, acids and alkalies, agricultural, optical, &c., instruments, roads, stone and cement, writing instruments and materials, saddlery, and bridges. All patentees are now required to deliver with the specification an abridgment of it, and these abridgments will be published in quarterly volumes after the expiration of the six months' protection. The commissioners reprint extracts from former reports on the need of a proper building for offices and public museum and library, and state that the present building is now filled, and there is a continual increase of specifications and scientific works, for which provision must be made. The large amount of surplus of fees received over expenditure provides a fund from which the cost of a proper building might be defrayed.

Great French Cannon at the Paris Exhibition.—The French have lately brought from Ruelle, where it was cast, to the quay of the Exhibition, an immense piece, 19 feet 8 inches long, weighing, independent of its support, 37 tons 1¼ cwt. It is said to be destined for one of the great ports. It is a smooth-bore breech-loader, the body being of cast iron, strengthened by two series of steel hoops. The trunnions are formed by one of the hoops of the under series. The diameter of the bore is rather more than 16½ inches. It is intended to throw both solid balls of 16½ inches' diameter, and having a weight of 661 lbs., with a charge of 110 lbs. of powder, and hollow shells weighing 463 lbs., holding 19¾ lbs. of powder, with a charge of 72½ lbs. of powder. The carriage, with the frame on which it rests, is made partly of cast and partly of rolled iron, and its weight, with the weight of the turntable, &c., by which the whole is supported, is 28 tons 1 cwt. The motion of the carriage on the frame is effected by a winch placed behind, and by an endless chain at each exterior side of the frame. By another endless chain passing under the breech, and worked by two pinions, and an endless screw and a crank handle, the piece is elevated or depressed. By means of a hoist at one side of the frame the ball is raised and placed in the breech. Around this cannon are placed specimens of the types now in use in the French navy, viz., four sizes of rifled cast-iron cannon, and two of bronze for boats. If the dimensions here given are compared with those of the great piece of ordnance made by Krupp, referred to on another page, it will be seen that though the French gun is larger by 26 inches, and has a bore greater in diameter by 2½ inches, it is much less heavy than the Prussian piece, and throws a much lighter shot.

A Great Natural Curiosity.—The *Sentinel*, published at Jacksonville, Oregon, of the 12th ult., says:—"Several of our citizens returned last week from a visit to the Great Sunken Lake, situated in Cascade Mountains, about 75 miles north-east from Jacksonville. This lake rivals the famous valley of Sinbad the Sailor. It is thought to average 2000 feet down to the water all round. The walls are almost perpendicular, running down into the water, and leaving no beach. The depth of the water is unknown, and its surface is smooth and unruffled, as it lies so far below the surface of the mountain that the air currents do not affect it. Its length is estimated at 12 miles, and its breadth at 10. No living man ever has been, probably ever will be, able to reach the water's edge. It lies silent, still, and mysterious in the bosom of the everlasting hills, like a huge well scooped out by the hands of the giant genii of the mountains, in unknown ages gone by, and around it the primeval forests watch and ward are keeping. The visiting party fired a rifle several times into the water at an angle of 45 degrees, and were able to note several seconds of time from the report of the gun until the ball struck the water. Such seems incredible, but it is vouched for by some of our most reliable citizens. The lake is certainly a most remarkable curiosity."

Liquor Protector.—In order to prevent the acidification of a liquid contained in a cask by the action of the atmosphere, which will enter the cask as a portion of the liquid is drawn off, M. Peret, a French inventor, proposes to obviate this by means of the apparatus shown in the annexed cut. The vessel placed upon the

barrel contains some chemical fluid, which deprives the air which comes into contact with it of its oxygen. The action of the apparatus is seen to be, that as the liquid of the barrel is drawn off below, the only way by which the atmospheric air is allowed to get in to supply the place of the liquid removed is by passing in at A, then through the chemical fluid, and finally through the tube B.

Mineral Statistics of the United Kingdom.—The following is a summary of the official returns of the mineral production of the United Kingdom during 1866:—

Coals.—Notwithstanding the severe depression of trade during the year upwards of 101,000,000 of tons of coals were produced, the rate of increase for the last few years being as follows:—

	Tons.		Tons.
1863	88,292,515		
1864	92,787,873	increase	4,495,358
1865	98,150,587	"	5,127,145
1866	101,630,543	"	3,479,956

The increase in our exportation of coal was 782,631 tons; therefore about 2,500,000 tons of coals will have been consumed in this country in excess of the previous year.

Iron.—The quantity of iron ore produced in this country last year was 9,665,012 tons, about 300,000 tons less than the quantity returned in 1865. In the same period the quantity of pig iron made was 4,530,051 tons, or 289,203 tons less than the production of our blast furnaces in the previous year. The value amounted to 11,326,127*l.*

Tin.—The tin ore produced from the mines of Devonshire and Cornwall was slightly less in quantity than that obtained in 1865, and the downward tendency in the metal market continued—the total production of tin ore in 1865 being 15,686 tons, and the mean average price 55*l.* 6*s.* 0*d.* per ton; in 1866 it was 15,080 tons, and the mean average price for the year was 48*l.* 10*s.* 9*d.* The distress occasioned by this condition of things has been, and continues to be, very great.

Copper.—The total quantity of copper produced in the United Kingdom was 11,147 tons, to obtain which our copper mines gave 180,378 tons of copper ore, nearly 16,000 tons less than the produce of 1865. During the year there was an increase of more than 7000 tons in the copper ore and regulus imported, nearly 56,000 tons coming to us from Chili alone. For copper and tin there were in former years upwards of 600 mines worked in our great western mining districts, whereas the lists for 1866 show that only about 300 are now in operation.

Lead and Silver.—Our lead mines produced as nearly as possible the same quantity of ore—a little above 91,000 tons—as they yielded in 1865, while there appears a falling off in the production of silver. This is rather apparent than real. A great number of the smaller mines of the north of England returned their produce as giving three and four ounces of silver to the ton of lead. It has since been discovered that much of this was never separated from the less valuable metal. This year this error has been to a considerable extent corrected.

General Summary of the Minerals raised and the Metals produced in the United Kingdom in 1866.

	Quantity of Minerals raised.	Estimated Value of Minerals raised.	Quantity of Metals produced.	Estimated Value of Metals produced.
		£		£
Coals, ... Tons	101,630,544	25,407,635	—	—
Iron, ... "	9,665,012	3,119,098	Tons 4,530,051	11,326,127
Tin, ... "	15,080	731,946	" 9,990	885,368
Copper, ... "	180,378	759,118	" 11,153	1,019,168
Lead, ... "	91,047	1,161,228	" 67,390	1,381,509
Silver, ... Ozs.	—	—	Ozs. 636,188	174,951
Zinc, ... Tons	12,770	42,655	Tons 3,192	69,916
Pyrites, sulphur ores, "	135,402	77,932	—	—
Gold, quartz, . . "	2,927	—	Ounces 743	2,656
Arsenic, . . Gossans, &c., Clays, fine, . Salt, . . . Barytes, . . } Estimated	—	825,000	—	—
Earthy minerals not returned (estimated), . .	—	650,000	—	—
Metalliferous ores and metals other than the above (estimated), . .	—	50,000	—	95,000
Total value of minerals,	—	32,824,612	Total Value of Metals,	14,954,695

The total value, therefore, of our Mineral productions for the year 1866 will be—

Metals obtained from the ores raised from British mines, .	£14,954,695
Coals, estimated price at the place of production, . . .	25,407,635
Earthy minerals (manufactured), not included in the above, not building stones, ...	1,350,000
	£41,712,330

In 1865 a considerable return was given of the mineral oil obtained from the cannel coals and bituminous shales of this country. The production of this has nearly ceased, owing to the excessive importation of the oils obtained from the mineral springs of America.

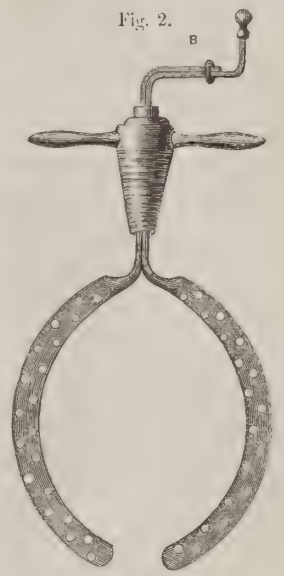
The Processes of Manufacturing Russia Leather.—The great mystery which has for so long a period enveloped the processes of producing Russian leather, and overtasked the ingenuity of other nations to imitate, appears at length likely to be cleared up, as the following particulars which, we believe, have been authoritatively obtained will indicate:—The best material for the red leather is goat skin, on account of its softness and smoothness; but the largest beef hides and ram's skins are also worked. The skins are first put into running water for one week, during which time they are taken out daily and thoroughly beaten with a wooden brake—a work of skill and patience, which breaks up the "nerve" and softens the fibre to a pulpy condition. Next, they spend a month in a lye made of lime or ashes, of which the exact quality, as we have no chemical description, must be left to judgment and experiment. The hair is then removed, and the alkaline properties are got rid of by soaking the skins in an infusion of white gentian in fresh water for twenty-four hours. The swelling of the skins is now a matter of particular care, for which they are soaked four or five days in a mixture of oatmeal and water. They are now ready for the tannin, which is extracted from the bark of the willow. (What special virtue there may be in the Russian vegetable products employed may possibly be worth an easy inquiry.) In the first solution the skins remain but three days, and are again beaten with the brake. The second solution, which is stronger than the first, retains them eight or ten days. They are then dried with the flesh side upward; again beaten, then greased, dyed, and finished—using logwood and alum for red, and alum and green vitriol for the dark colour. The mode of dyeing is peculiar. A number of skins are sewed up into the form of a sack, closed all around except a small opening at one end to admit the dyeing liquid. They are kept in motion in the dye until it has reached all parts, and then hung up to drain. The exclusion of light and air, and the slow draining in close contact, may have some importance in practice. The skins are then dried, and again dyed with a sponge. The whole process is repeated two or three times. They are next greased again on the flesh, and grained with a notched stick passing through the length and breadth of the skin until small furrows are gradually produced. After graining, they are greased again with birch or linseed oil, and put on the wooden horse to be smoothed. The birch oil contributes evidently to the undefinable characteristic odour by which Russia leather is distinguished.

Experiments with Safety Lamps.—Within the last few weeks some experiments have been going on at the Barnsley Gas-works for the purpose of testing the relative securities of the various safety lamps in use by miners. The experiments were conducted by Mr. Hutchinson, the manager, and Mr. Wilson, the steward of the Darfield Main Colliery. There was a considerable attendance on both days of viewers and proprietors, and the results were of a rather extraordinary character. For the purpose of the experiments, a rectangular box, about 12 feet long, 11 inches by 4 inches inside, was attached to the flue of the retort-house chimney, the draft being three-tenths of an inch, as indicated by the water-gauge, and, by the anemometer, was found to travel at the rate of 5 miles an hour, when regulated by a damper. Inside the box was a glass sight-hole, opposite to which the lamp to be tested was placed. When all was in readiness a stream of gas was allowed to flow into the end of the box sufficient to surround the lamp with an explosive atmosphere. The different lamps were then tested, with the following results:—The Davy lamp, with the shield on the outside, exploded the gas in six seconds, and with the shield inside the gauze in nine seconds; the Belgian lamp exploded in ten seconds, the Mozard in ten seconds, the small Clanny in seven seconds, and the large ditto in ten seconds, and the Stephenson in seventy-five seconds. The Stephenson is, consequently, the best, the glass cracking before going off. It will thus be seen that none of the so-called safety-lamps can be depended upon when coming in contact with a strong explosive current of fire-damp and air, but are, in reality, mere indicators of danger, it being clearly demonstrated that all lamps will explode when the mixture is sufficiently strong. The subject is one of deep importance, showing that for the future not so much dependence as there has been ought to be placed in any of the lamps in use.

Bignon's Agitator.—This implement is intended to be passed through the bung-hole of a barrel for the purpose of agitating its contents; for example, when wines are being treated with white of egg in the process of clarifying them. After

Fig 1.

Fig. 2.



having been inserted into the barrel in the form shown in fig. 1, the rod, A, is turned into the position shown in fig. 2, which causes one of the perforated blades to separate from the other. The conical body above them plugs the bung-hole, and is there held by the handles, whilst B is being turned, which causes the blades to revolve, and thereby to agitate the liquid.

A Parisian Wall-Paper Manufactory.—The most complete establishment in Paris, especially for the manufacture of wall papers by machinery, is that of Messrs. Gillou & Thorailler, who produce about one-eighth of the total quantity made in France. The following table shows the relative value of the home and foreign business:—

Sales in Paris, ...	250,000 francs.
Sales in the provinces, ...	650,000 "
Sales in America, Great Britain, Netherlands, Russia, Scandinavia, Turkey, Germany, Italy, Spain and Portugal, ...	1,100,000 "
Total, ...	2,000,000 francs.

The proportion of Great Britain in the above sum is nearly 400,000 francs. They employ steam power and machines for multicoloured printing, which enables them to print mechanically twenty or twenty-two colours at a time. Perceiving that their manufacture required the aid of the artist to maintain it in the first rank, they called upon several eminent men to furnish them with designs, and their success is in part owing to this step. The plant which they employ consists of—One 14-cylinder printing machine, three 8-cylinder do., four 4-cylinder do., six machines for "grounding" the paper, fourteen hanging machines, three pressing machines, a 20-horse engine, a 10-horse engine, eighty plate-printing tables, six hand-printing machines, and six printing machines, from two to three colours. Only animal size is employed, whilst the English manufacturers use vegetable matter. The French method, though more costly, insures a result superior in every respect, the colours being more brilliant and durable, more in relief, and giving more body to the paper. It is consequently better able to withstand the operation of attaching the hangings to the wall.

Kaolin.—This name, obtained from the Chinese, is applied to the earth used in making porcelain. It is derived from the decomposition of granitic rocks, and is composed of felspar and quartz. It is sometimes of a fine grain, sometimes of a rough grain, according to the degree of decomposition. There is mingled with it in its native bed a greater or less amount of clay, which is separated by washing, and then the residue becomes pure porcelain earth. Hence the kaolins are classed as argillaceous, sandy, and pebbly. The first mentioned of these is the richest in

useful material, and it is the scarcest. After removing the sandy particles and washing, good kaolin is found to contain about 48 per cent. of silica and 37 per cent. of alumina. Cornwall has long been noted for its kaolin. A very excellent quality of kaolin is obtained near Limoges in France, and Brittany also yields good kaolin. In addition to its use in the manufacture of porcelain, kaolin is employed in the manufacture of alum, with a marine blue, paper, and cardboard. It is also mixed with grease for the lubrication of railway wheels and axles.

APPLICATIONS FOR

PROVISIONAL PROTECTION FOR INVENTIONS

UNDER THE PATENT LAW AMENDMENT ACT.

☞ When the city or town is not mentioned, London is to be understood.

17th August, 1867.

2368 A. M. Clark, Chancery Lane—Metal castings.—A com.
2369 J. W. Dixon, jun., and W. Buttery, Sheffield—Fire-arms
2370 F. B. Houghton, Reading—Treating vegetable products
2371 W. W. Pocock, Craven Street—Measuring apparatus
2372 M. Cahen, Paris—Sealing letters
2373 W. R. Goulty, Reading—Machinery for cutting

19th August, 1867.

2374 T. Tunstill, Burnley—Size for warps
2375 J. Cronier, Hoxton—Boots and shoes
2376 W. B. Adams, Blackheath—Treating iron
2377 J. Hooker, New Wandsworth, and F. Brady, Euston Road—Fire lighters
2378 C. E. Brooman, Fleet Street—Ornamenting fabrics. - A com.
2379 W. E Newton, Chancery Lane—Crank motions.—A com.
2380 F. and G. Parkes, Birmingham—Spades
2381 C. Reisert, Frankfort-on-the-Maine—Railway carriages
2382 E. A. Cowper, Great George Street—Safes

20th August, 1867.

2383 A. Martin, Clothfair—Hat shapes
2384 W. Burrow, Great Malvern—Aerated waters
2385 W. Dixon, Westminster—Saving life in cases of fire
2386 H. Clidland, Bradford—Treating skins of animals
2387 A. S. Stocker, Bermondsey—Caps for bottles
2388 A. Cohen, Birmingham—Watches.—A com.
2389 J. Murgatroyd, Heaton Norris—Steam boilers
2390 W. Bostock, Manchester—Spools, reels, or bobbins
2391 C. E. Hall, Leeds—Hoeing turnips

21st August, 1867.

2392 W. Thomas, Liverpool—Omnibuses.—A com.
2393 J. Robinson and J. Smith, Rochdale—Saw frames
2394 G. Luyckx, Brussels—Waterproof tubes
2395 C. W. Siemens, Westminster—Metallurgical operations
2396 J. Sainty, Burnham Westgate—Hurdles
2397 J. Goucher, Worksop—Preserving life in water
2398 J. M. Napier, Lambeth—Coining presses
2399 J. Maugnall, Glasgow—Elastic mattresses
2400 T. Widdowson, Sheffield—Umbrellas and parasols

22nd August, 1867.

2401 A. Smalley, Preston, B. Crossdale and W. L. L. Leaver, Blackburn—Looms
2402 T. Sault, Chancery Lane—Slide valves
2403 J. Newark, Coventry—Fire-arms
2404 S. Lynes, Burley—Lubricators
2405 R. King, J. Lowden, and W. Gartside, Oldham—Carding engines
2406 C. Newsome, Sheffield—Metal joints
2407 D. Howard, Dobcross—"Union" fabrics
2408 A. M. Clark, Chancery Lane—Raising water.—A com.
2409 J Jones and F. J. Jones, Birmingham—Fire-arms
2410 J. Garth Marshall, Leeds—Detergent processes
2411 H. Higgins and T. S. Whitworth, Salford—Spinning
2412 T. W. Lawson, Liverpool—Ships and vessels
2413 J. M'Intyre, Jarrow—Protecting metallic plates
2414 J. L. Norton, Ludgate Hill, and G. Hawksey, Caledonian Road—Combustible liquids

23rd August, 1867.

2415 F. Ziffer, Bury, and W. Goodbrand, Salford—Warming railway carriages
2416 D. Whittaker, Blackburn—Looms
2417 H. A. Bonneville, Paris—Self-acting cooking apparatus.—A com.
2418 D. Taylor, Hatton Garden—Closing bottles
2419 W. S. Ashton, Darwen—Metallic packing
2420 W. R. Lake, Chancery Lane—Iron and steel.—A com.
2421 E. A. Dana, Brooklyn—Concussion fuzes
2422 J. Varley, Plumstead—Supplying water to steam boilers

24th August, 1867.

2423 G. Allibon and E. Wilson, Worcester—Steering ships
2424 J. and J. Cash, Coventry—Manufacture of towels
2425 A. and E. Wigzell, Sowerby Bridge—Furnaces
2426 J. P. Smith, Hereford—Agricultural implements
2427 J. Hanson, The Bush—Digging roots
2428 M. Samuelson, Hull—Sewing machines
2429 W. E. Newton, Chancery Lane—Fastenings for paper parcels.—A com.
2430 H. Davey, Gunnislake, and D. Davy, Sheffield—Supplying water to steam boilers
2431 W. R. Lake, Chancery Lane—Fire-arms.—A com.
2432 P. Kniaghininsky, P. Galahoff, and N. Ossipoff, Paris—Distributing printing types
2433 F. J. Cleaver, Red Lion Street—Screw presses
2434 W. Berby, Stamford Hill—Removing rubbish from streets

26th August, 1867.

2435 W. C. Thurgar, Norwich—Supply of gas to burners
2436 E. Sonstadt, Maughold—Obtaining valuable products from sea-weed
2437 W. R. Lake, Chancery Lane—Producing green colour.—A com.

27th August, 1867.

2438 G. Haseltine, Chancery Lane—Iron and steel.—A com.
2439 W. Muir, Montreal—Uniting fabrics
2440 J. W. Webb, Woolwich Common—Reefing topsails
2441 W. E. Gedge, Strand—Crushing bones
2442 E. B. Bigelow, Boston—Driving looms
2443 J. A. A. Etaix, Covent Garden—Screw propellers
2444 M. A. Soul, Leadenhall Street—Fastening iron bands on bales.—A com.

28th August, 1867.

2445 T. Sagar and T. Richmond, Burnley—Looms for weaving
2446 H. Hanson, Stockport—Finishing cotton
2447 J. E. Boyce and R. Harrington, Birmingham—Umbrellas and parasols
2448 W. Wilson and J. Cowburn, Radcliffe—Looms for weaving
2449 G. G. Tandy, Penge—Preparing vulcanizable compounds
2450 W. Pedder, Savage Gardens—Brushes
2451 J. Elliot, Southampton—Cutting coal
2452 J. H. Johnson, Lincoln's Inn Fields—Aeration of fresh water obtained by the distillation of sea water.—A com.
2453 J. Storey and W. E. Bickerdike, Lancaster, and W. V. Wilson, Mile-End—Bronzing metallic surfaces
2454 W. T. Watts and D. J. Fleetwood, Birmingham—Hydraulic presses
2455 W. B. Smith, Coventry—Lever watch movements
2456 R. Edwards, Ashford—Locomotive traction engines

29th August, 1867.

2457 J. Macintosh, Regent's Park, and W. Bogget, Chelsea—Springs for boots and shoes
2458 C. D. Abel, Chancery Lane—Production of phosphorus.—A com.
2459 H. J Simlick, Bow—Cigar and pipe lights
2460 A. Stewart, Hamilton—Textile fabrics
2461 J. Douglas, Bloomsbury Street—Regulating the draft of fire ranges
2462 C. Slagg, Kingston-on-Thames—Application of sewage to land
2463 J. and G. W. Dyson, Tinsley, and S. Martin, Sheffield—Cutting up iron and steel rails
2464 J. and R. D. Paulin, Newcastle-on-Tyne—Feeding paints
2465 W. Muir, Pimlico—Stopping railway trains
2466 A. M. Clark, Chancery Lane—Apparatus for submarine exploration.—A com.
2467 W. E. Newton, Chancery Lane—Steering apparatus.—A com.
2468 A. M'Nutt Wier and M. A. Weir, Bayswater—Signalling apparatus
2469 W. E. Newton, Chancery Lane—Rudders.—A com.

30th August, 1867.

2470 J. Silvester, West Bromwich—Spring balances
2471 A. M. Clark, Chancery Lane—Cutting hides of animals.—A com.
2472 R. Weare, Wolverhampton—Furnaces
2473 J. Dixon, Liverpool—Submerged propeller
2474 M. Hammerstein, Liverpool—Cigars and pipes.—A com.

31st August, 1867.

2475 A. H. Brandon, Paris—Carpet stretcher.—A com.
2476 J. A. Brown, Kingsland Road—Propelling ships
2477 W. J. Matthews, Birmingham—Fire-arms
2478 W. Aubert, Strand—Diffusing perfumes
2479 A. Fenton and J. Sandilands, Redditch—Fishing rods and hooks
2480 D. Nicoll, Kilburn—Telegraph conductors

2nd September, 1867.

2481 E. K. Dutton, Manchester—Window sash fasteners.—A com.
2482 H. O. W. and E. F. Cooper, St. George's Road—Watering roads
2483 R. Watson, Liverpool—Brakes for railway trains
2484 C. Gelstsharp, Wincomble—Manufacture of malleable iron
2485 A. V. Newton, Chancery Lane—Tool for cutting stone.—A com.
2486 H. Vallance, Farnham Royal—Fastenings for casement windows

3rd September, 1867.

2487 C. Tessier, Paris—Paper-making machines.—A com.
2488 W. R. Pape, Newcastle-upon-Tyne—Fire-arms
2489 A. Field, Lambeth, and W. B. Nation, Old Kent Road—Ornamenting candles
2490 A. Leigh, Baguley—Finishing woven fabrics
2491 J. M'Kechnie, Glasgow—Applying concentrated heat
2492 A. E. Gelhaye, Croydon—Manufacturing chains
2493 P. F. Lunde, West Square—Obtaining extracts from vegetable substances
2494 E. Y. Robbins, Cincinnati—Fire grates
2495 L. N. Le Gras, Wardour Street—Milk cans
2496 E. T. Archer, Great Trinity Lane—Spring mattresses
2497 A. M. Clark, Chancery Lane—Carving ivory.—A com.

4th September, 1867.

2498 G. Smith, Upper Thames Street—Ladders
2499 G. Crane, Surrey—Removing snow from roads
2500 H. G. Graham, Blackburn—Apparatus for heating size
2501 W. Weldon, Highgate—Production of artificial oxides
2502 G. W. Howard, Queen Square—Ball cartridges
2503 F. B. Daering, Westminster—Machinery for boring
2504 J. K. Smythies, Paddington—Flying apparatus
2505 F. H. and J. W. H. Pattison, Glasgow—Metal founder's blacking
2506 G. T. Bousfield, Brixton—Paddle wheels.—A com.
2507 J. Howard and E. T. Bousfield, Bedford—Cutting grass or corn
2508 G. A. Buchholz, Shepherd's Bush—Hulling wheat

5th September, 1867.

2509 R. A. Jones and J. C. Hedges, Aylesbury—Fire-escapes
2510 A. C. Henderson, Charing Cross—Embroidering fabrics.—A com.
2511 W. H. Kitson, Leeds—Railway wheels
2512 L. B. Pothier, New Orleans—Securing metal bands.—A com.
2513 H. Carter and J. H. Edwards, Stepney—Fire-arms
2514 G. Cope, Liverpool—Shaping cigar bunches
2515 J. Ford, Reading—Securing wheels on shafts
2516 J. S. Henderson and J. Macintosh, Aberdeen—Metallic canisters
2517 G. H. Pierce, Yatton—Padding for horse collars
2518 E. Bernheim and W. Wilson, Bradford, and E. Longworth, Levenshulme—Preparing printed warps
2519 J. B. Handyside, Glasgow—Railway buffer
2520 A. V. Newton, Chancery Lane—Valves for steam boilers.—A com.
2521 H. Gardner, Manchester—Miner's safety lamps
2522 F. Versmann, Stratford—Varnishes

6th September, 1867.

2523 N. Seward, Riversdale—Motive power
2524 S. Cassan, St. Pancreas—Curing asthma
2525 T. Hodson, W. Mather, and J. Risley, Bedford—Lubricating shafts
2526 W. G. Creamer, Woburn Place—Excluding dust from railway carriages
2527 T. W. Helliwell, Brighouse—Looms
2528 A. M. Clark, Chancery Lane—Construction of ships.—A com.
2529 J. G. Tongue, Chancery Lane—Manufacture of garments

7th September, 1867.

2530 T. Cook, Pitt Street—Sewing machines
2531 J. J. Hicks, Hatton Garden—Lighting gas
2532 J. Cockshoot, Manchester—Manufacture of carriages
2533 J. Smith, Bradford—Combing silk
2534 J. B. Rogers, Hastings—Launching life boats
2535 J. Armstrong and E. Ecclestown, Birmingham—Steam engines
2536 E. Hubner, Paris—Rotary steam engine
2537 D. Payne, Otley—Priming machinery
2538 J. and T. Bayley, Lenton—Manufacture of leather
2539 B. F. Stevens, Covent Garden—Illuminating roofs.—A com.
2540 H. Woods, Manchester—Extracting liquids from hops
2541 J. Whitham, Leeds—Puddling
2542 R. W. Ewer Cheapside—Winders

INTERCONTINENTAL TRUNK LINES.—THE EUPHRATES VALLEY RAILWAY.

Amongst the reports of last session is one by Mr. J. Savile Lumley, her Majesty's secretary of embassy at St. Petersburg, entitled a Report upon the Inland Tea Trade of Russia, which is of unusual interest and importance. As treating in a masterly way on the resources of countries in the centre and north of Asia, of China, and of Asiatic Russia, which are almost unknown to Europeans generally, this report may be studied with pleasure by the geographer and the engineer.

But it is to the statesman and British merchant that it presents, or ought to present, the most striking and not to be forgotten information. We find from it how little indeed we know here at home of the gigantic strides in the conquest of territory, and for the firm establishment of its own power, and of some elements of its own sort of civilization, Russia has already made in Central Asia, and upon the remote Amur on the western coast of the Pacific.

We can, after reading this report, far better understand than ever we have been able before, why Russia should have so readily consented to the disposal to the United States of her vast North American territories, and why America should have been so eager for the purchase. Allied as these two powers are, bound together by certain common interests and sympathies, though with institutions formally, at least, the most utterly inconsistent with each other—we can now understand how these two great powers, stretching out hands to each other from opposite sides of the Pacific, must mutually benefit in peace; and with Russia almost girdling in our Indian empire upon the north, from the Caspian to the Pacific, and now established actually within a few miles of our frontier at its most accessible point, how in time of war, with these tremendous allies in concert against us, we should have to struggle to hold our own.

To the south and east of India, again, France is pushing her way rapidly into Cochin China, annexing province after province (taking a leaf out of our book of the early occupation of India), and obviously fully intending to found there a great French Eastern empire to balance our own. What a vantage ground, in the event of great European complications, enabling France there to quickly accumulate great armaments, and make a fatal lunge at Calcutta before we should have time to support our power there from home.

Meanwhile France steadily pursues the Suez Canal, and in the progress from day to day aggrandizes her own national influence and power in Egypt, and prepares the way for the endeavour to shut us out, when the time is ripe and need for it shall come, from the navigation of the Red Sea, and from our only short road to India. The remedy for all this is best found, not in wars or diplomacy, but in the opening of new high-roads for ourselves. Austria, it is said, seriously considers the advisability of a railway going straight from Belgrade, through the Balkan, to Constantinople. With less immediate probability of execution, it is proposed to cross the Bosphorus, and carry on this great trunk line along the southern shore of the Euxine, and to join into the vast system of internal navigation and even of railways which Russia has formed, or is promoting, between the Euxine, the Caspian, and even Lake Baikal and the Pacific on the Amur.

Now, if ever, would be our time to revive with effect and to realize the long talked of project of the Euphrates Valley Railway; to complete our Indian trunk lines from Delhi up to Peschawar in the Punjaub, so as to enable us to meet Russia readily, rapidly, and on our own chosen base, with an army, whenever she shall attempt the aggression; and from Delhi to Kurrachee, to complete that favourite child of Sir Charles Napier, as a fine and safe harbour for ocean steamships; and finally to establish our own new line of communication with India by the Gulf of Scanderoon in the Mediterranean, the Euphrates Valley Railway, the lower reaches of that great river, and across the Persian Gulf to Kurrachee. The line is almost upon a great circle from London to Kurrachee, if we had the railway link diagonally across Asia Minor from Constantinople to the Gulf of Scanderoon filled in. This seems a large project, but it is one that must and that will be done; and if we English do not take it in hand, before even a few years more shall have passed, the opportunity itself will most probably have passed from our hands into those of others.

This would really be the means of holding together, nay even, of breathing some new life, through European energy, enterprise, and settlement, upon the half-dead Turkish empire. This would be the most effectual means, moral and military, of keeping Russian ambition in the Levant and East in check, and it would to a great extent neutralize the possible future evil effects of France's operations in Egypt, and of our most mistaken and ill judged past policy with respect to the Suez Canal.

No time could be better for again urging forward the Euphrates Valley and the Punjaub railways than the coming spring. Enormous capital, laid idle by the folly, fraud, and rascality of baseless projects at home, fills the vaults of the banks of England and of France. It cannot remain there idle very much longer. England, France, Central Europe, present less and less opportunity for great engineering projects of a justifiable character, in proportion to the vast extent of works already executed in these. The great trunk lines that are to unite the ends of the earth, now invite, nay, press for execution. As surely as the feeble coasting steam navigation of forty years ago led out into the great lines of ocean steamships, so must the completion of the great network of internal railways over Europe, lead to the execution of those vast trunk lines of railway that shall unite the most distant regions of continent with continent.

Nor will these vast intercontinental railways prove chimerical and disastrous projects, as probably many of the half-informed, and so cautious world of capital would imagine. European railways generally are not now any *bonne bouche* as paying speculations; a few pay some 8 or 9 per cent. the vast majority from 3 to 4 only. Into the reasons of this we cannot now enter; but we do venture to affirm that no railways that can be now projected are likely to command the vast traffic and to pay the great dividend, that must the one or two great trunk lines which before very long shall connect Asia and Europe, and over which shall pour the riches, natural and manufactured, of the oldest civilizations and of the most instructed and energetic peoples of our globe.

The Panama Railway over the Isthmus of Darien, though having its points of difference, is really a case in point. It was one of the most expensive lines, mile for mile, ever made in any part of the world. The dividend that it has paid from the commencement, and which it still continues to pay, is unequalled by that of any other line in the world. Why is it so? Because this line is so far the sole railway link of connection between the two great oceans—between the east and the west coasts of northern and of southern America, stretching from the Arctic to the Antarctic zones. Its passengers alone enable it to pay a splendid return. The great Atlantic and Pacific Railway, when completed, will present probably much the same result and for the same reasons. The argument applies equally to the extension by a great trunk of the Austrian S.E. lines across Turkey and on to the shore of the Persian Gulf. In time of European peace all the passenger traffic between Europe and Asia nearly, would pass over the whole of such route; in time of war we should be able to fall back upon the Euphrates Valley alone, holding firm possession of our right of passage in the Mediterranean from Gibraltar to Scanderoon.—Ed.

ON SOME POINTS OF PRACTICE IN IRON FOUNDING.

No. XXI.

(*Continued from page* 198.)

As respects *distinction between the upper and lower layers of the furnace charge*, there are several causes which make the upper and lower strata of the iron in a reverberatory furnace to differ. First, the temperature of the upper layers is higher than that of the lower ones; then there is the chemical action of the gases and of the materials of which the furnace is constructed; and lastly, the influence of gravity, which in cast iron in a state of fusion, as in all other liquids, causes the upper layers to be lighter. The upper layers are thus simultaneously lighter and hotter, and consequently continue to remain near the surface, and to become more and more heated; whence it results that there must be some difference between the upper and lower layers. The American experiments have not more than touched upon this question.

Those of the fifty-one 24-pounder howitzers mentioned under No. 3 of Table VIII. were cast successively with iron from the same furnace; the first from the lowest part of the charge, the second from the middle, and the third from the upper part. Test bars were cast at the same time.

TABLE XI.

Part of the Charge of Iron in the Cupola from which the Pieces were Poured.	Gaits.		Test Bars.	
	Density.	Tenacity.	Density.	Tenacity.
Lower, ...	7·270	35,014	7·339	31,477
Middle, ...	7·287	32,804	7·350	34,484
Upper, ...	7·278	33,597	7·351	37,136

The table shows that the test bars cast from the upper part of the charge had a greater density and tenacity than those from the lower part, but that this was not true in the case of the gaits.

Contrary to the general opinion of founders, the iron of the gait coming from the lower part of the liquid mass of metal showed less tenacity than that of the others; but the difference is too small to be conclusive.

There is on other accounts a good reason for preferring the upper part of the charge, namely, that the iron coming from the lower part being colder, and often thick, gives rise to blowings and imperfections.

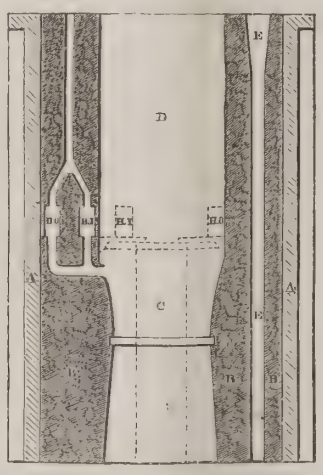
In 1848 there was cast at Boston, among other pieces, a 24-pounder gun, which was run by means of a siphon from the iron of the lower part of the charge up to within 30 inches of the gait. The rest of the mould was then filled with iron from the upper part of the charge. The gun was rejected on account of flaws which existed in the middle and at the breech. The trial of the test bar and of bars cut from different parts of the gun gave the following results:—

TABLE XII.

Nature of the Bar.	Density.	Tenacity.
Test bar, ...	7·407	37,260
Do. cut from the gait, ...	7·343	27,675
Do. from behind the muzzle, ...	7·314	34,035
Do. from the chace reinfort, ...	7·331	32,415
Do. from the first reinforce, ...	7·331	31,050

The bar cut from the gait only gave a slight resisting power compared with the others, a defect which probably arose from some breach of continuity, which often happens in gaits from the contraction of the metal. The bar cut near the muzzle was slightly less strong than the two succeeding ones; but the first came from the upper part of the charge, and the two others from the lower part, so that in this case experience gave a result the reverse of that shown in Table XI. It appears, then, that the distinction between the different layers of the charge has no governing influence; and that the iron of the upper part has no other advantage than that of being more fluid, and consequently of rendering flaws less probable than the iron of the lower part.

Effect of Re-heating the Iron.—It is known that the qualities of cast iron are changed by its being re-heated after having been allowed to



cool: the iron becomes less hard and less dense. The effect of re-heating cast iron has been examined at Boston in the following manner in 1851:—In the thickness of the sand mould of a 32-pounder gun, and at the height of the lower part of the gait, were made two cavities, BI and BO, in the form of test bars (fig. 1). The first of these cavities was made as near, and the second as far from the walls of the gait, as possible. These two cavities were in communication by a channel terminating in the gait mouth, and therefore were filled at the same time as the gait. But by the arrangement which we have just described, the bar BI, cooled at first by contact with the sand, becomes afterwards re-heated by the heat disengaged from the gait. Independently of the bars BI and BO, two bars, HI and HO, were cut from the gait. All these details are shown in the figure. AA is the moulding box, BB the mould of sand, C the cannon, D the gait, and E the siphon for pouring. The following table gives the results of the experiments on the four bars:—

TABLE XIII.

Amenia iron: three parts at third melting, and one part at fourth melting.

Bars.	Density.	Tenacity.
HI, ...	7·329	33,646
HO, ...	7·316	35,810
BI, ...	7·274	27,502
BO, ...	7·386	30,163

The inferior density and strength of the bar BI, as compared with BO, shows the injurious influence of the re-heating. As to the inferior strength of the bar BO, as compared with HI and HO, it is probable that it arose from its density exceeding the limit corresponding to the maximum tenacity, as has been already said; and also perhaps because the bar BO has to some extent undergone the re-heating action which proved so injurious to the bar BI.

Strength of the Gun in its Various Parts.—In order to see how far the metal might differ in the same piece, two guns cast at Pittsburg in 1851 were cut into sections perpendicular to the axis, and three specimens were taken from each section, namely, one from the outer surface, one from the middle of the thickness of the walls, and one from near the inner surface of the bore. Experiment gave the following results:—

TABLE XIV.

Guns.	Distance of the Section from the Breech in inches.	Specimens taken from each Transverse Section.						Means for each Section.	
		Near the Outer Surface.		At the Middle Thickness.		Near the Surface of Bore.			
		Density.	Tenacity.	Density.	Tenacity.	Density.	Tenacity.	Density.	Tenacity.
8-inch Columbiad,	121,	7·289	36,891	"	"	7·295	39,031	7·292	37,961
	83,	7·285	39,298	7·287	36,170	7·280	38,557	7·284	38,008
Means, . .		7·287	38,095	7·287	36,170	7·288	38,794	7·288	37,895
10-inch Columbiad,	122,	7·273	40,457	"	"	"	"	7·273	40,457
	81,	7·271	36,147	"	"	7·314	40,099	7·292	38,123
	54,	7·289	35,289	"	"	7 294	34,486	7·292	34,887
	36,	7·275	34,216	"	"	7·320	26,826	7·297	35,521
	17,	7·292	37,654	"	"	7·297	35,585	7·295	36,620
Means, . .		7·280	36,753	"	"	7·306	36,747	7·290	37,122

The distances given in the second column correspond to the following parts of the guns:—

121 and 122, the neck of the rising head (*masselotte*);
81 and 83, the middle of the chace;
54, immediately in front of the trunnions;
36, immediately in rear of the trunnions;
17, the middle of the chamber.

This table shows that the metal of the same piece is not very homogeneous; for instance, in the 10-inch columbiad the densities vary from 7·271 to 7·320, and the tenacities between 34,216 and 40,457. Thus there is no apparent regularity in the variations.

It is generally admitted that the metal is less tenacious near the surface of the bore than near the exterior surface. At the interior the metal is grayer and the grain coarser than at the exterior; and these qualities are considered as signs of a low power of resistance. The preceding table shows that this difference did not exist in the two cannon under trial. Nevertheless it is probable that if the hardness of the metal had been experimented upon, a difference would have been detected in this respect.

Although we have as yet no very certain data as to the utility of long rising heads as regards cast-iron guns, it is generally admitted that the rising head should have sufficient length to prevent the flaws produced by the shrinkage of the iron from reaching further than the muzzle of

the gun. Yet some founders are of opinion that the use of the rising head in iron, as in brass guns, is to increase the density, and consequently the strength of the metal. If this were so, the metal of the breech, which has the whole length of the body of the gun acting as does the rising head, should be denser and stronger than the rest of the gun; but the figures of the last column of the preceding table show the contrary to have been the case.

The inferior tenacity of the metal in the immediate vicinity of the trunnions may be explained by the irregular contraction of the metal, owing to the angular forms in this part. Still it would be improper to draw formal conclusions from a small number of particular cases, for the exceptions are numerous as far as cast iron is concerned. It is only by means of a great number of experiments, whereby the influence of anomalies becomes neutralized, that it is possible to judge properly of the various circumstances which affect the strength of cast iron. Hence we have determined, through the numerous results given in Table II., whether the densities and tenacities of the different parts of guns follow a determinate law. For this purpose we have deduced the means for each class of cannon, after adding two columbiads to the first class, namely, one 8-inch, No. 33, cast at Westpoint in 1845, and one 10-inch, No. 1, cast at Boston in 1846. The result of this inquiry is given in the following table:—

TABLE XV.

Number of Cannons of each Class.	Direction of the Axis of the Specimen in Relation to the Axis of the Piece.	Place whence the Specimens were Taken.						Means.	
		At the Muzzle.		Between the Trunnions.		At the Breech.			
		Density.	Tenacity.	Density.	Tenacity.	Density.	Tenacity.	Density.	Tenacity.
Six of the 1st class, includ. Columbiads,	Perpendicular,	7·201	26,970	7.193	25,794	7·207	25,813	7·200	26,127
	Parallel, . .	7·231	29,798	7·183	24,548	7·202	27,535	7·205	27,294
	Means, . .	7·216	28,384	7·188	25,171	7·204	26,576	7·203	26,711
Seven of the 2nd class,	Perpendicular,	7·138	21,021	7·140	20,097	7·140	20,843	7·139	20,654
	Parallel, . .	7·180	22,909	7·158	22.794	7·148	21,928	7·162	22,544
	Means, . .	7·159	21,965	7·149	21,446	7·144	21,386	7·152	21,599
Eight of the 3rd class,	Perpendicular,	7·066	17,192	7·079	17,212	7·082	18,864	7 076	17,756
	Parallel, . .	7·060	18.524	7·073	17,635	7·107	20,192	7·080	18,784
	Means, . .	7·063	17,858	7·076	17,424	7·095	19,528	7·078	18,270

The following table shows the mean densities and tenacities of the twenty-one guns:—

TABLE XVI.

Specimens Taken.	Density.	Tenacity.
At the muzzle, ...	7·146	22,736
Between the trunnions, ...	7·138	21,347
At the breech, ...	7·148	22,497

These results confirm those obtained from Table XIV. The metal near the trunnions appears to really offer less resistance than that of the chace and breech, and its density is a little less. The strength and density of the metal taken at the breech are not superior to those of the metal of the muzzle, so that a long rising head would not be of any advantage. Yet, if the three classes of guns be examined separately, a certain difference in this respect will be observable.

The guns of the first class give the following means:—

TABLE XVII.

Specimens Taken.	Density.	Tenacity.
At the muzzle, ...	7·216	28,384
Between the trunnions, ...	7·188	25,171
At the breech, ...	7·204	26,576

The guns of the second class give—

TABLE XVIII.

Specimens Taken.	Density.	Tenacity.
At the muzzle, ...	7·159	21,965
Between the trunnions, ...	7·149	21,446
At the breech, ...	7·144	21,386

The guns of the third class give—

TABLE XIX.

Specimens Taken.	Density.	Tenacity.
At the muzzle, ...	7·063	17,858
Between the trunnions, ...	7·076	17,424
At the breech, ...	7·095	19,528

We see by these tables that in the gun of the first class the metal taken at the breech is inferior to that of the muzzle, both in density and tenacity, which confirms the observations on the subject in the case of the 8-inch columbiad (Table XIV.), which piece should also be placed in the first class. In the guns of the second class also, the density is less at the breech than at the muzzle, but the tenacity is the same. On the other hand, in the guns of the third class, the density and tenacity are greater at the breech than at the muzzle. It appears, then, that long rising heads have an injurious influence on good kinds of iron, but are of advantage when gray and inferior qualities are used.

Table XV. shows, besides, that the tenacity of the specimens taken parallel to the axis of the bore is greater, in general, than that of those taken perpendicular to this axis.

Before proceeding to the next portion of these investigations of the American War Department, it may be well that we should notice our own total incapacity to agree in the last conclusions, as above stated. If the increased pressure of the rising head increase the density of the casting, it *must*, on principles already explained in previous articles, increase the tensile resistance, according to some as yet unknown function of the increase of density. If so, that which produces in a perceptible degree such an effect upon inferior *qualities* of cast iron, must also, *pro tanto*, produce it on superior ones also, though probably in less degree, because such iron is already probably nearly as dense as it can be made to become.

The true cause of why the gun casting at the place of the *trunnions* is weaker and less dense than elsewhere, is to be found in the internal molecular cross strains, which are there introduced by the change of form due to those members of the gun. This has been fully explained in 1854, by Mallet, in his work on the "Materials of Artillery," and in some degree in preceding articles of this series.

II.

Different Modes of Proof.—As a general proposition, the strength of a cannon depends, in the first instance, on the tensile strength of the metal; but it also depends on many other circumstances, which it is difficult to reduce to a precise theory. For instance, the toughness or capability of the material of large elongation has a considerable influence, &c. Thus, to determine the strength of a gun the inquiry must not be limited to a trial of the tenacity only. Any proof which should consist in submitting a hollow cylinder to the action of an increasing internal pressure, would evidently approximate to the effect of the gases in cannon. This mode has been tried in America, conjointly with the first. For this purpose round pieces of cast iron were cut, to which was given an annular form; on to these rings was introduced a tempered steel mandril of a truncated conical form, and the force necessary to be applied to the mandril to produce rupture was determined.

To reproduce, as far as possible, the conditions of a bursting cannon, the rings should be concentric with the axis of the bore, and have the same calibre. This is very important, for, as we shall see further on, the strength of a cannon depends chiefly on the interior strains of the iron. It is necessary, then, that these tensions should be the same in the rings as in the cannon, and this equality can only be obtained in the way indicated. This principle has been observed in some of the American experiments, but in most cases, rings of small dimensions were used. Unfortunately, in these experiments no measures were taken to reduce or ascertain the amount of friction; it is evident that the force necessary to rupture the ring would be considerably increased by the friction of the mandril, and that a small difference in this friction might have a great influence on the result. This oversight was considered in America also as the principal cause of the non-success of the experiments.

Hydrostatic Proof.—The experiments in which hydrostatic pressure

was employed gave much the most accurate results. In these experiments, after having closed the vent, the muzzle of the gun was stopped with a cast-iron tompion, to which a tube was attached, communicating with a powerful force pump; water was then forced into the piece until it burst. To make the closing of the bore staunch, the tompion was furnished with an annular cupped leather; the water pressure was indicated by a weighted valve.

Four cannons were subjected to this test:—Two 18-pounders, and one 24-pounder of the same casting, and one 6-pounder cast at Boston in 1844. The latter had withstood a firing proof with heavy charges. When the pressure in the 24-pounder had reached 9000 lbs. per square inch, the water passed through the thickness of the cannon so abundantly that the pressure fell to 5000 lbs., and it was found impossible to exceed this figure, even by working the pump as quickly as possible. Strangely enough, the greater part of the water came out of an opening which existed in the muzzle; but as the tompion extended at least 4 inches into the gun, the water must have passed along through the thickness of the gun before arriving at this opening, which proved a great want of homogeneity in the iron.*

The following table shows the pressures which burst the three other cannons, as well as their thicknesses, and the density and tenacity of the bars cut from the pieces:—

TABLE XX.†

No. in Order.	Calibres of the Pieces.	Density of the Iron.	Thickness of the Walls in Calibres.	Cannons.		Bars.	
				Pressure which produced Rupture.	Calculated Pressure.	Tensile Strength.	Calculated Tenacity.
				Lbs. per sq. inch.	Lbs. per square inch.	Lbs. per sq. inch.	Lbs. per sq. inch.
1	18-pounder gun,	7·312	½	9,000	{14,393 / 16,342}	27,359	{16,925 / 1,493}
2	18-pounder, .	7·328	0·81	9,860	{13,639 / 16,684}	22,204	{15,873 / 13,156}
3	6-pounder, No. 7,	7·213	¼	12,400	{12,800 / 13,128}	34,297	{33,780 / 32,100}
4	6-pounder, No. 7,	7·213	½	20,000	{17,267 / 19,571}	32,761	{37,606 / 33,182}

The iron of the two 18-pounders was very hard.

The American report runs thus:—Iron hard, fracture bright and compact, presenting the same general characteristics, though in a less degree, as the third 18-pounder, which was subjected to the proof by firing, and the metal of which was so hard as not to be touched by the file. A bar cut from this gun showed a density of 7·384, and only 16,849 lbs. per square inch of tenacity. The piece burst at the fourth round, with 9 lbs. powder and four balls.

Columns 7 and 10 of the preceding table give the pressures and resistances calculated according to the theory of the resistance of cannon inserted in the *Journal d'Artillerie Russe* in 1858.‡ The calculated pressures are deduced from the tensile strength of the bars, and the calculated tenacity of the bars is deduced from the pressure which sufficed to burst the piece. The two values attached to each piece or bar show the limits between which the true value must lie, according to the aforesaid theory, which assumes that there are no interior strains in the metal, other than those arising from the action of the powder.

If we compare the theoretical with the experimental results, it appears that the agreement, as far as regards the 6-pounder, is as close as we could hope for. As regards the two 18-pounders, on the other hand, we remark a great divergence between theory and experiment. This disagreement cannot be explained by any want of homogeneity in the iron. In fact, the pressure which burst these guns was much less than that which they should have been able to withstand, according to the established tenacity of their test bars. Thus the first gun, whose test bar showed a resistance of 27,359 lbs., burst under a pressure which should have been borne by a gun whose proof bar would only have given a resistance of 15,000 to 17,000 lbs. We have no hesitation in attributing this anomaly to the existence of interior strains in the two 18-pounder guns. Further on we shall examine into the effects of these strains, and we shall see that they are often the cause of guns, which appear sound and good in all respects, bursting at the first round.

It remains to explain how interior strains could exist in the two 18-pounder guns, and not in the 6-pounder cast by the same processes. The reason of the difference lies in the great hardness of the metal of the two former, while the iron of the third was comparatively mild, as may be seen by comparing the densities. This explanation will be confirmed further on.

Nature of Proof at present adopted in America.—The mechanical proof of the metal of cannons offers great advantages over the method of proof by firing. First, the proof by firing can only be put in practice when the piece is completed, and it requires a great expenditure of time and money; for if it be wished that it should be conclusive, ordinary charges only can be employed, to the exclusion of extraordinary charges, from which nothing positive can be deduced. Again, only a certain number of guns in each series can be submitted to the test by firing, and it is thus necessary to suppose that all the others have the same qualities as those which have been tried; but such an assumption is somewhat hazardous in the case of such a variable metal as cast iron. The mechanical proof gives the means of checking the variations of the metal during every step of the manufacture. It is done simply, quickly, and cheaply; and even before the piece is bored sufficiently, sure indications of the quality of the metal can be obtained. Lastly, if, as in America, a bar from each rising head be tested, it appears immediately in any series of guns cast whether there be any, or many, differing from the others in the quality of their metal. This advantage possessed by the mechanical test is of itself of sufficiently great importance, even if the test bar gave no indication of the strength of the finished cannon. For, in fact, as soon as we have the means of ascertaining that the metal of all the guns of a series is of the same quality, the proof by firing of a single one of these guns suffices to judge more or less exactly of the value of all. It is on these considerations that the proof of cannon in the American foundries is now based.

(To be continued.)

* The reporters must not be misunderstood as here intending to convey that at 9000 lbs. per square inch of pressure the water was forced universally over the surface of the guns, through the molecular pores of the cast iron, assuming such to have been in existence. What they mean is obviously that irregular cavities, fissures, cracks, or minute tubes, existed here and there, which were found out by the water under this great pressure, and by which it escaped.

Though often repeated as a loose statement that water can be forced through the substance of a solid casting of good cast iron, there is not a shadow of foundation for the statement, not even when both the interior and exterior "skins" of the casting have been removed by boring and turning. Every example quoted, when narrowly sifted, will be found either to contain proof of *the metals having been unsound*, or that no sufficient caution in observation was exercised to make sure that this was not the case.—Ed.

† This table differs slightly, as regards the calculated pressures, from that given by the author of the article entitled, "A Few Words on the Theory of Colonel Gadolin," in *Terssen's Revue Militaire*, &c. The differences show—first, that the author has given the resistances of the test bars of the two 18-pounders in round numbers only, and next that he has taken 2300 kilos. per square centimetre for the resistance of the bars of the 6-pounder, while in reality the resistances of the two bars of this gun are, respectively, 2401 and 2293. We must here remark that if the tenacity of the 6-pounder be calculated from the mean resistance of the two bars, 2347 kilos. per square centimetre, we get 880 to 904 for the walls of ¼ calibre in thickness, and 1242 to 1408 for those of ½ calibre, figures which approach still more nearly to the results of experiment. Colonel Gadolin forgets to say how the 6-pounder gun could have a thickness of both ¼ and ½ calibre. The article which we have just quoted supplies this omission.

‡ On the resistance of the walls of cannon to the gases of the powder fired, by Colonel Gadolin, see the *Revue de Technologie Militaire*, tome iii.; the formulæ (73) and (76), which give the two extremes, are found at page 51 of that volume.

To assist those who may wish to check the calculations, or otherwise to make use of formulæ (73) and (76), we think it well to remark that any values may be given to r_2 and r_1, provided that their difference shall be equal to the thickness of the walls expressed in terms of the radius r. Thus the thickness of the walls being ½ calibre, we have $r_2 - r_1 = r$, and making for example $r_1 = 1$, we have $r_2 = 2$, and consequently $P = \frac{3}{5} U$, or $\frac{9}{17} U$, according as we adopt formula (73) or formula (76) with $m = \frac{1}{3}$. If the thickness is ¼ calibre, we have $r_2 - r_1 = \frac{1}{2} r_1$, whence $r_2 = \frac{3}{2}$, and $P = \frac{5}{13} U$ or $\frac{3}{8} U$. Lastly, if the thickness be 0·81 of a calibre, we have $r_2 - r_1 = 1{\cdot}62\ r$, whence $r_2 = 2{\cdot}62$, &c. In these formula P is the pressure in the bore per unit of surface, and U the absolute strength of the bars per unit of surface of transverse section. The formula referred to are

$$P = U\left(\frac{r_2^2 - r^2}{r_2^2 + r_1^2}\right) \quad \ldots\ldots\ldots \quad 73.$$

and

$$P = 2\,U\left(\frac{r_2^2 - r_1^2}{(3 - m)\,r_2^2 + 2\,m\,r^2}\right) \quad \ldots\ldots \quad 76.$$

U = the maximum safe tensile strain, multiplied by the elongation at that strain. m is a compound coefficient of elasticity, deduced from consideration of Wertheim's and other experiments, for which the memoir must be consulted.

THE RICHARDSON PROCESS.

RICHARDSON *versus* BESSEMER.

AFTER what we hinted at in our first article* on this subject, with reference to the probable purity of the iron produced, and from the clear and decidedly distinct view we there expressed in regard to the removal in particular of phosphorus and sulphur, prior to a reliable analysis being made; it will be expected of us, now that such analysis is in our hands, that we should make a clean breast of all the facts. This we proceed to do; and a careful perusal of the following remarks will convince our readers that the truth of the entire aspect we took in theory is fully borne out in its practical results. It is to us naturally a matter of satisfaction to be able to make such an assertion, particularly so when a contemporary, with such apparent fervour of its power, is desirous of consigning the advantages of a process discovered in 1866, into the safe keeping of Mr. Bessemer's impractical, and therefore unpractised, patent for manufacturing iron of 1855.

We propose here to preface a few remarks as to Mr. Bessemer's proposed process for manufacturing malleable iron. In his paper read before the Institution of Civil Engineers, May 24, 1859, Mr. Bessemer remarked thus:—"Chemical investigation soon pointed out the real source of difficulty. It was found that, although the metal could be wholly decarbonized, and the silicium be removed, *the quantity of sulphur and phosphorus was but little affected.* As different samples were carefully analyzed, it was ascertained that the red shortness was always produced by sulphur, when present to the extent of one-tenth per cent., and that cold shortness resulted from the presence of a like quantity of phosphorus. It therefore became necessary to remove these substances. Steam and pure hydrogen gas were tried, with more or less success, in the removal of sulphur; and various fluxes, composed chiefly of silicates of the oxides of iron and manganese, were brought in contact with the fluid metal, during the process, and the quantity of phosphorus was thereby reduced. . . . . New patents and new apparatus followed in due course, when it was *happily* [the italics are ours] suggested, that if it were possible to obtain some comparatively pure pig iron, free, or nearly so, from sulphur or phosphorus, a proof would at once be given of the correctness of the views entertained with reference to these substances. Such a specimen of iron having been procured, it was found that steel of a fair average quality could be readily made from it. Indian and Nova Scotia iron were next tried, and no doubt was then entertained of the value and ultimate success of the process. The results thus obtained caused a total change in the direction in which the efforts of Messrs. Bessemer and Longsdon were directed. It was determined by them at once to import some of the best pig iron from Sweden, from which iron and steel of excellent quality were made, and the produce was used for almost every purpose for which the highest qualities of steel are employed. It was then decided to discontinue, for a time, all further experiments, and to erect steel works at Sheffield, for the express purpose of fully developing and working the new process commercially, and thus correcting and setting at rest the erroneous impressions that were generally entertained with reference to the invention.

"In manufacturing tool steel of the highest quality, it was found preferable, for several reasons, to use the best Swedish pig iron, and when converted into steel by the Bessemer process, to pour the fluid steel into water, and afterwards to remelt the shotted metal in a crucible, as is at present practised with blister steel, by which system the small ingots required for this particular article are more perfectly and more readily made. The production of first-class steel by the new process, although a matter of deep interest in one of the smaller branches of the iron trade, still left untouched that great source of this country's prosperity, the manufacture of malleable iron. It was therefore impossible to rest content without accomplishing this, the original object of the invention. On examining into the stores of mineral wealth so abundant in these islands, it was found that iron ore of the requisite purity existed in vast and apparently inexhaustible beds; that of hæmatite alone as much as 970,000 tons were raised annually, and that a demand only was required to double or treble that quantity. There are also extensive beds of spathose, white carbonate, and magnetic ores, of a quality unrivalled in the whole world. Although these superior ores may not lie in the immediate centres of the coal and iron works, yet the vast network of railways which now spreads over the whole breadth of the land may be made available for its transit, and thus not only the most valuable ores may be supplied to the ironworks, but the traffic will be a source of profit to those great carrying establishments which apparently, at present, yield only a small return for the capital employed in their construction."

Now all this, if Mr. Bessemer ever really believed it could be realized, certainly looks like a chimerical view of an over-sanguine inventor. He admits most distinctly that the ordinary and principally used ores of the British islands, from which first-rate malleable iron is constantly made, he had found it impossible to use for producing iron by his process, purely on account of the phosphorus and sulphur difficulty. It is perfectly true that malleable bar and plate iron has been manufactured under the patent of 1855. Samples, indeed, of such were exhibited before the Institution; and although a good deal is stated in the paper as to their superior mechanical qualities, we do not find a word as to the ores from which they were made; hence we conclude, as we justly must, that hæmatite, or some slightly or non-phosphoric ore, altogether different from the ordinary run of British ores, must have been employed. Dr. Percy has the following sentence, which unquestionably takes the true position of the Bessemer process in so far as the production of malleable iron is concerned; and it may be as well here to remind our readers that these remarks apply to iron alone, and have no reference to Bessemer steel:*—"*Bessemer's process is powerless to convert ordinary kinds of pig iron into merchant iron of the least value, whereas this is every day accomplished by the old and barbarous method of puddling. With the exception of certain varieties of red hæmatite, all our iron ores contain a sensible amount of phosphoric acid, of which, practically, the whole of the phosphorus passes into the pig iron smelted from them.* The proportion, however, raised of the former is small in comparison with that raised of the latter; but it is only with pig iron practically free from phosphorus that Bessemer can deal satisfactorily, and such pig iron forms merely *a fraction of the total* produced in this country. It will be time enough for Mr. Bessemer to sneer at puddling, when he can show how that laborious operation may be dispensed with. He has not yet done so."

With regard to the quantity of phosphorus in iron that may be considered to have an injurious effect, Karsten, the able German metallurgist, who wrote about twenty-six years ago, formed the opinion that as long as phosphorus is present in no greater quantity than 0·5 per cent. there is little cause for apprehension respecting the quality of the iron; and that up to 0·3 per cent. the only effect of phosphorus is to make iron harder, without sensibly diminishing its tenacity. Iron not containing more than this proportion of phosphorus might be properly regarded as of the best and strongest quality.†

Is it, then, remarkable, that Mr. Bessemer is unable to adapt his process to the ordinary British ores? The following analyses show to what extent phosphorus and sulphur are combined in Bessemer iron:—

Name of Element.	Pig Iron, per Cent.	Bessemer Iron, per Cent.
Carbon,	3·309	0·218
Silicon,	0·595	None
Sulphur,	0·485	0·402
Phosphorus,	1·012	1·102
Carbon,	3·383	0·281
Silicon,	1·630	None
Sulphur,	0·206	0·371
Phosphorus,	1·090	1·966

These analyses indicate that the silicon is completely oxidized out of the iron, in this respect producing purer metal than by the puddling process. In the first analysis the sulphur is diminished by 0·083 of the amount originally contained in the pig iron; but the phosphorus is increased from 1·012 in the pig iron to 1·102 in the Bessemer iron—an increase of 0·090 of the original amount. In the second analysis the sulphur is increased from 0·206 in the pig to 0·371 in the finished iron —a difference of 0·165 of sulphur added to the metal; whilst the phosphorus is also increased from 1·090 in the pig to 1·966 in the Bessemer iron—a difference of 0·876 in favour of the phosphorus. It is rather difficult to assign positively the cause of the increase of these two elements in the Bessemer iron; and it can only be looked for as coming from the

* Vide *Practical Mechanic's Journal*, pp. 137–38, Vol. III. Third Series.

* Metallurgy, Iron and Steel. By John Percy, M.D., F.R.S., etc. London. 1864. Murray. P. 820.

† Handb. d. Eisenhüttenkunde. Berlin. 1841. Vol. i. p. 420, sec. 188.

fuel with which the pig is re-melted prior to being poured into the refining vessel or converter. Comparing the results, however, with what Karsten had ascertained, can we wonder at the cold and red shortness of Bessemer iron? Since Karsten's time, however, the investigation of the mechanical qualities of iron has received so much attention, that it is probable his assertion is not strictly correct; as it has been shown that under a steady tension hard iron (and that to a very large extent, independently of the effect of carbon, probably means an iron in which a large proportion of phosphorus is combined) resists a greater load than a soft tough iron; but that if the tension is suddenly applied, or should chance to receive a jerk during the application of the strain, it is found to fracture under a less load than a soft tough bar, which stretches often to a considerable extent previous to fracture.

Before proceeding to consider the analysis of the iron produced by the Richardson process, it will be as well to inspect some analyses of the best kinds of British puddled iron. Let us take that of Lowmoor, for instance; and in so doing we adopt the armour plate given at page 735 of Percy's great work. The analysis was made for the Lowmoor Company by Mr. Tookey, Dr. Percy's assistant. The results are these:—

Carbon,	0·016
Silicon,	0·122
Manganese,	0·280
Nickel,	Distinct traces.
Cobalt,	" "
Sulphur,	0·104
Phosphorus,	0·106
Iron, by difference,	99·372
	100·000

In this case the difference between the sulphur in Bessemer iron and Lowmoor armour plate is compared with the first of the analyses given above—

Bessemer Iron.		Lowmoor Armour Plate.		Difference.
0·402	—	0·104	=	0·298

compared with the second—

Bessemer Iron.		Lowmoor Armour Plate.		Difference.
0 371	—	0·104	=	0·267

The results with regard to phosphorus are, however, far more striking. In the first case the difference of this element in the Lowmoor and Bessemer irons is—

Bessemer Iron.		Lowmoor Armour Plate.		Difference.
1·102	—	0·106	=	0·896

compared with the second—

Bessemer Iron.		Lowmoor Armour Plate.		Difference.
1·966	—	0·106	=	1·860

We might easily extend comparisons of this sort to great length, but it is needless to do so; and we shall now content ourselves with citing the analysis of the best Staffordshire puddled iron, which gives—

Carbon,	0·190
Silicon,	0·144
Sulphur,	0·165
Phosphorus,	0·140
Iron,	99·361
	100·000

Karsten observed that iron containing 0·6 per cent. of phosphorus will not stand the breaking test, but stands the test of bending at right angles, and pretty well that of striking over the anvil; and with 0·66 per cent. it does not, under these tests, manifest the characteristic qualities of cold-short iron, properly so called. As soon as the proportion of phosphorus reaches 0·75 per cent., the decrease in tenacity is very notable, and the iron no longer endures the tests previously mentioned. With 0·8 per cent. of phosphorus, iron is to be regarded as decidedly cold-short; and with 1 per cent. a bar can no longer be bent at right angles. Still further, Karsten observes that all iron which contains more than 1 per cent. is exceedingly brittle. What, then, are we to think of Bessemer iron, with its 1·102 per cent., or worse still, 1·960 per cent., of this element.

In none of the best makes of British puddled iron does it appear that the silicon is completely eliminated. This element, however, the powerful oxidizing action of the Bessemer process appears to completely get rid of. Neither is it got rid of in the highly-reputed Swedish iron, where it varies from 0·15 to nearly 0·30 per cent.

We now arrive at that portion of this paper which is by far the more important—the analysis of iron produced at the Glasgow Ironworks by the Richardson process; and our readers should especially bear in mind that the iron analyzed was made from such pigs as are used for making *common* Scotch bar iron, and not such pigs as are used by Bessemer for his process; whilst the Lowmoor iron cited above was no doubt made of superior pigs.

RICHARDSON'S PROCESS.

Name of Element.	Square Bar.	Round Bar.
Iron,	99·569	99·648
Carbon,	0·035	0·031
Silicon,	0·076	0·075
Sulphur,	0·025	0·028
Phosphorus,	0·031	0·034
Manganese,	trace	trace
	99·736	99·816

The analysis was made by Dr. Stevenson Macadam, Professor of Chemistry at the Royal College of Surgeons, Edinburgh, and to the analysis he adds, "the above malleable iron is exceptionally free from impurities, especially *in relation to sulphur and phosphorus*, which are present only in comparatively *minute* proportion;" and in writing on the subject to the author of this paper, he adds, "I regret much the delay which has apparently occurred in reporting upon the iron, but I was anxious to make all the steps with my own hands. Moreover, the sulphur and phosphorus were repeatedly determined; indeed, I had to use a larger amount of the iron than usual for the estimation of the phosphorus; and last of all, I again went over the whole process without stopping the analysis, from day to day till completed."

Such facts as we have now put together require no further comment, as the readers of this journal can make with ease any further comparison themselves; but they will not fail to discover the great purity of the metal in which sulphur and phosphorus are practically almost wanting; indeed, we know of no iron wherein these elements have ever before been so completely taken away, and their reduced amount points out most clearly that some influence must be exerted in the puddling furnace to eliminate them.

It need no longer, as it appears to us, be exclaimed that the Bessemer process is inapplicable for making iron out of the common ores, for here is a process that will produce iron purer than the best Lowmoor or Bowling iron from the very worst pigs used for producing common Scotch bar. Mr. Beardmore, of Parkhead, appears to take this view of the matter, and we mistake very much if, as soon as his works are in readiness for the process, he does not produce armour plates purer and tougher than anything hitherto attacked at Shoeburyness.

It is possible that some persons may doubt the continued applicability of the process. We have heard it said, "Oh, the furnace bottom will be burnt!" We merely reply to such a question, that if the bottom is kept covered with a proper charge of metal, it will never be injured, so long as there is molten metal in quantity for the injected oxygen to attack. And again, as to any difficulty of continuous production, we reply, Given the same conditions of furnace and pressure of blast used at the Glasgow Ironworks, where the experiments were carried on for hours together, and the same (*commonest*) pigs, where is the cause that will obviate the continuity of production? The process as yet has not passed beyond the experimental stage, it is true, but with what results? and it must not be forgotten that such experiments are not of the puny description that usually go by that name; they were made on a scale, and in such a manner as the process is intended to be practised. It is rather singular that the whole of the silicon was not oxidized out of the iron; with a stronger pressure of blast, however, we believe this will be effected.—V. D.

COMBINED DREDGER AND HOPPER BARGE, BY MESSRS. WILLIAM SIMONS & CO., RENFREW.

In the engravings we illustrate a combined dredger and hopper barge, as well as a novel arrangement of dredger for undercutting land at the sides of water. Altogether, the combination in the first case appears to be one on which important benefit must rest, and in the second case the appliance looks like a good practical tool for projecting harbours, and other similar works landwards.

The first arrangement has for its object the combining together, so as to constitute one apparatus, that which has hitherto consisted

as two separate and distinct appliances used for the dredging and conveying away of the material dredged—namely, the steam dredger proper and the hopper barge. The hull of the dredger is built with a well to receive the ordinary bucket ladder in the usual manner, and the aft or forward end of the hull is formed of larger capacity than usual, constituting in fact, and forming, the hopper cavity or space into which the dredged material is discharged from the buckets, to the entire exclusion of hopper barges or mud punts at present in use. As soon as the hopper is full the bucket ladder is raised into the well, the combined dredger and hopper is propelled or navigated out to sea, or to any place where it is desired to deposit the dredgings; on arriving at which the doors at the bottom of the hopper are opened and the dredgings discharged, after which being effected the doors are closed, and the vessel returns to carry on the dredging, for which purpose

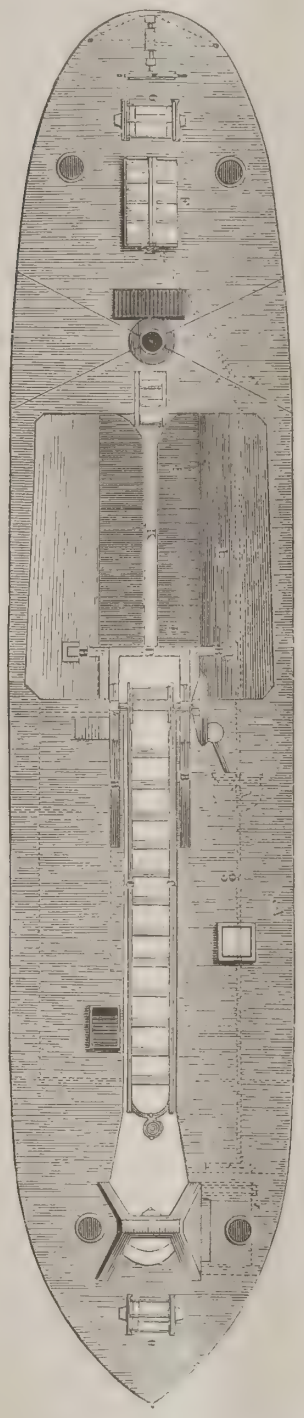


Fig. 2.

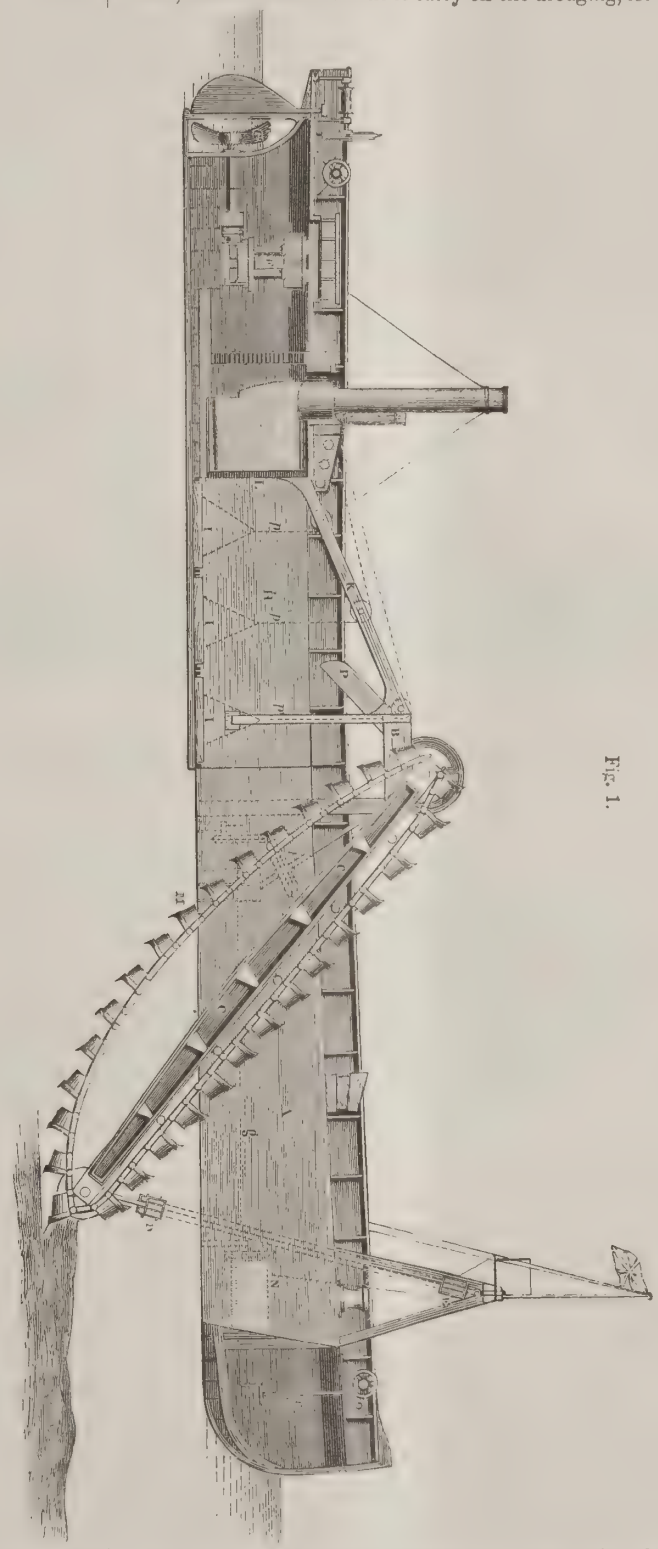


Fig. 1.

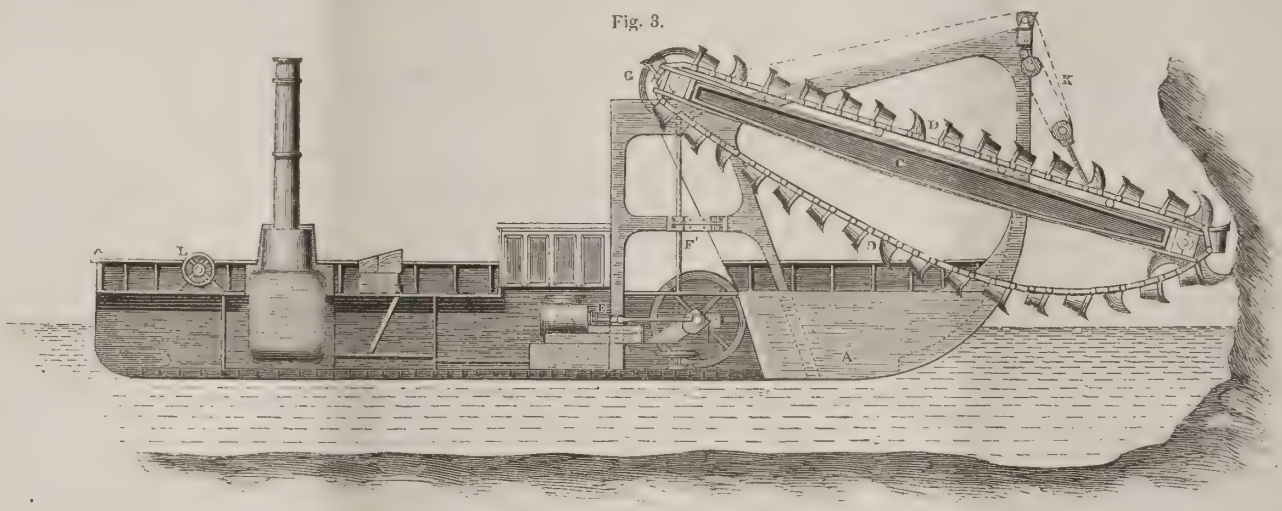
the bucket ladder is lowered as before. By means of thus combining together into one vessel the dredger and hopper barge, the mud punts and hopper barges at present in use are dispensed with, whilst at the same time the crew ordinarily required for dredging operations is considerably diminished, and the expenses attendant thereon correspondingly reduced.

The second arrangement relates to so constructing the dredger that it may be used in addition to the ordinary dredging operations, for the purpose of excavating or undercutting land above or at the surface of the water, the sides of canals, rivers, embankments, and coasts. The ladder is so arranged that it may be elevated out of the water and raised to any required position, projecting over one end of the well, so

that the buckets may be brought to act upon the parts above water requiring to be excavated or undercut. It is intended thus to undercut the parts requiring removal, thus allowing the upper portions to break off or detach themselves through their own weight; and after the material has fallen into the water the bucket ladder is lowered to raise it in the ordinary manner.

Fig. 1 is a transverse vertical section of the combined dredger and hopper barge. Fig. 2 is a plan of the same. In the figures the hull of the combined dredger and barge is marked A. The form and arrangement of the main framing, B, which carries the upper end of the bucket ladder, C, is shown at figs. 1 and 2; fig. 1 showing the apparatus in the act of dredging. The lower end of the bucket ladder is suspended by blocks and tackle, D, from the shears, E, in the ordinary manner, by which its depth of cut can be regulated, as well as the ladder and buckets raised or lowered as required. At the aft or stern end of the hull the engines, F, are fixed, and when it is necessary to move or navigate the combined dredger and hopper barge from one place to another, these engines are employed to drive the screw, G; but when dredging operations are commenced the screw is disconnected, and the engines are used for driving the dredging apparatus. In the figures 1 and 2, the hopper, H, is shown, its bottom being made tight by means of the doors, I, which are connected by hinges at their outer ends to the bottom plates of the hull, as in an ordinary hopper barge; and across the centre of the space above the hopper, H, the bridge or frame, K, is placed, being firmly attached to, and forming part of the main framing, B, as well as being secured at its opposite end to the bulkhead, L, thus acting as a stay to the main framing, B, as well as constituting a bridge or girder in which are carried the rollers over which the chains, *f*, pass for holding up the doors constituting the bottom of the hopper, H: the chains, *f*, are retained by palls catching into the teeth of ratchet pinions on the end of the chain rollers, *g*. The engine, F, actuates the chain of buckets, M, through the gearing in figs. 1 and 2, shown in dotted lines, this being arranged that it may be thrown out of gear when necessary, and another shaft, *g*, is arranged to be actuated by it for the purpose of driving the chain barrel, N, figs. 1 and 2, so that the ladder may be raised or lowered when required. When, however, the

Fig. 3.



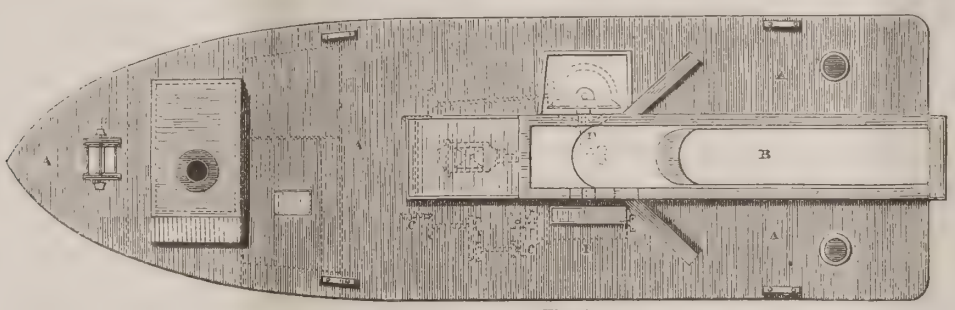


Fig. 4.

position of the ladder is fixed, the barrel, N, is secured or held by any convenient clutch, or other arrangement for holding it; and during the dredging operation, the crab, or winch, O, by which the dredger is drawn up continuously against the work, is kept in motion by means of the bevel gearing actuating the vertical shaft, *f*, which in turn drives the winch, and the hauling ropes are thus wound up.

During the dredging operations the dredged materials or "dredgings" are discharged by means of the shoot, P, into the hopper, H, and when this is full the ladder and buckets, C and M, are raised into the well. The screw, G, is put in motion and the vessel navigated to any place where it is desired to discharge the "dredgings," this being effected by opening the doors, I, constituting the bottom of the hopper, so that the material may fall out; the doors being opened of their own weight, as well as the insistent weight of the dredgings, on slackening the chains, *p*, as is usual with hopper barges.

The dredgings being discharged, the vessel, or combined dredger and hopper barge, is navigated back to the place of operation, and the dredging process is continued as before.

Figures 3 and 4 are respectively a longitudinal section and plan of a dredger to be used for excavating or undercutting land above or at the surface of the water, the sides of canals, rivers, embankments, harbours, and coasts, or for other generally similar purposes. The chief peculiarity of this apparatus is that the hull, A, is formed with the well, B, continued from midships or thereabouts right through the stern, so that the ladder, C, and chain of buckets, D, may be elevated to any position required for cutting or excavating under any circumstances, and for the special purposes referred to; while the hull, which carries the whole machinery, floats in the water. By preference a horizontal engine, E, is employed for driving the chain of buckets. On its crank shaft, F, fig. 2, a bevel wheel is fixed, gearing into a bevel pinion on the vertical shaft, F, which in turn drives through bevel gearing, G, the top tumbler, H, by which the buckets, D, are actuated; whilst on the side of the engine opposite to that from which the buckets are driven the chain barrel, I, is placed, which may be actuated by gearing, as shown at *c c*, fig. 2, or in any other convenient manner. By means of this hoisting gear the chain, K, for elevating or lowering the ladder and buckets, C and D, is actuated, and when raised or lowered to the required position the barrel, I, is fixed and disconnected from the engine, so that the cutting or excavating may proceed. It is to be understood that the dredger now described may also be used as an ordinary dredger, for which purpose the ladder and buckets are lowered. —V. D.

THE NEW BRIDGES OF PARIS.

WITHIN the fortifications of the city of Paris there are no fewer than twenty-seven bridges, connecting either bank with bank, or the two islands of the Seine with one or other shore. Of these bridges fifteen have been either entirely erected during the present reign, or they are old bridges in great part restored. Although upwards of £680,000 have been laid out upon these structures (exclusive of the great viaduct at Auteuil), this sum is only a small part of what has been expended during the comparatively short reign of Louis Napoleon upon the external features of the city of Paris. So great have been the alterations and improvements that Paris may be considered a new city, and incomparably the finest capital in the world. However Napoleon III. may be handled hereafter by history, he has made an ineffaceable mark upon the metropolis of France.

In the machinery gallery of the Exhibition was to be seen a collection of models, plans, and photographs, which the minister of Public Works sent there to give visitors an idea of what has been lately done in the way of bridge-building at Paris. He has also printed a volume containing descriptive notices, not only of these models, but of many others connected with the public works of France; and it is to this volume that we are indebted for the materials of our paper.

PONT DE NAPOLEON III.

The most easterly of the Paris bridges is that which bears the name of Napoleon III. It was built in 1852–53, and has a width of 50½ feet, about half of which is devoted to the railway which passes round Paris within the fortifications, and is termed Chemin de Fer de Ceinture. The other half of the bridge serves for ordinary purposes. This bridge consists of five arches, which are segments of circles, each having a span of rather more than 113 feet, with a rise of 15 feet. There are also two passages serving for quay roadways, each having a width of 39 feet. The thickness at the crown of the arches is 3 feet 11 inches. The cost of this structure amounted to £89,476.

PONT DE BERCY.

This bridge, a little lower down the Seine, connects the Boulevard de Bercy on the right bank with the Boulevard de la Gare on the left. It is a stone edifice, replacing a suspension bridge which formerly stood at the same place, and it was erected in 1863–64 at a cost of £53,395, one-half of which was borne by the state, the other half by the city of Paris. It is 63 feet wide between the parapets, of which rather more than one-half is taken up by the carriage way. It consists of five elliptical arches, the middle one of which has a span of 95 feet 1½ inch, with a rise of 26 feet 3 inches. The arch at each side of the middle one has the same span, but the rise is about 1 foot 6½ inches less. Lastly, the external arch at each side has a span of 91 feet 9½ inches, and a rise of nearly 23 feet. The arches have a thickness of 3 feet 3½ inches at the crown, and 3 feet 11¼ inches at the spring. The piers are 13 feet 1½ inch thick, and the abutments 24½ feet.

PONT D'AUSTERLITZ,

originally built as an iron bridge in the reign of the first Napoleon, had become so dangerous in 1854, by reason of the breaking of several of the arches, that it was deemed advisable to rebuild it. The bridge connects Place Mazas on the right bank with the left bank at the Jardin des Plantes. It was found that the original foundations had been so firmly laid that they would bear a superstructure of stone, and it was accordingly resolved to rebuild it of that material. The new bridge is 69 feet wide between the parapets, and 36 feet 1 inch of this space are occupied by a carriage way, the rest by the side paths. There are five arches, segments of circles, having each a span of 105 feet, but varying in their rise from 13 feet 2¼ inches to 15 feet 2¾ inches. The thickness at the crown is nearly 4 feet 1¼ inch. The alterations were made in 1854, and the expense amounted to £38,048, which was divided between the state and the city.

PONT LOUIS PHILIPPE.

This bridge of stone was erected in the years 1860–62, in place of a suspension bridge which formerly stood here. It is one of the three bridges which connect the upper island with the right bank of the Seine, and it has a width between the parapets of 49 feet 6½ inches, of which nearly two-thirds are devoted to the carriage way, and the rest to the side paths. It is formed of three elliptical arches, the middle one of which has a span of nearly 105 feet, with a rise of nearly 28 feet; and each of the two side arches a span of 98 feet 5 inches, with a rise of 25 feet 4 inches. The arches have a thickness of 3 feet 3⅓ inches at the crown, and of 4 feet 10 inches at the spring. The piers are 13 feet 1½ inch thick, and the abutments 9 feet 10 inches. The cost was £31,402, and it was borne by the state and the city in equal proportions.

PONT ST. LOUIS.

This bridge, which affords the only direct communication between the two islands, superseded a suspension bridge pulled down in 1860. It has a width of 52½ feet, of which 32 feet 9¾ inches are occupied by the carriage way, the rest being given up to side walks. It consists of a single segmental arch of cast iron, having a span of 209 feet 11½ inches, with a rise of nearly 19 feet. It is skew at an angle of 78°. It is composed of nine ribs, having a height of 3 feet 7 inches at the crown, and 5 feet 9½ inches at the spring. The total weight of the iron employed was 755,927 kilogrammes (1 kilogr. = 2·2046 lbs. av.). The abutment on the left bank is nearly 32 feet 9¾ inches thick, that on the right bank 29½ feet. The total cost (which amounted to £26,226, of which £15,000 went for the iron work) was divided between the state and the city. The new bridge was opened to the public in 1862.

PONT D'ARCOLE,

erected in place of a suspension foot bridge, connecting the lower island with the right bank, near the Hotel de Ville, has a width of 65 feet 7½ inches between the parapets, of which three-fifths are taken up by the carriage way, and the rest by the side paths. It consists of a single segmental arch of iron of 262½ feet span, with a rise of 20 feet 0⅜ inches, the spring being 15 feet above low-water mark. The arch is composed of twelve iron ribs, having a thickness of 4 feet 4 inches at the spring and 13⅜ inches at the crown. This bridge was erected in 1854–55, and the expense, which amounted to £45,720, was shared in equal proportions by the state and the city.

PETIT PONT.

The bridge which formerly stood here had three very narrow arches with such thick piers that both navigation was obstructed, and the water when rising had not space enough to pass through. That bridge was pulled down in 1852, and the present structure erected in its place. It connects the lower island with the left bank, and has a width of 65 feet 7½ inches between the parapets, three-fifths of that space being occupied by the carriage way. Its single stone arch is segmental, with a span of 104 feet 0¾ inch; the thickness at the crown is 4 feet 5 inches. The cost amounted to £15,420.

PONT NOTRE DAME.

This bridge is one of four that connect the lower island with the right bank of the river. Having an inconvenient rise in the middle, it was determined to lower it some 8½ feet, and to connect it by a gentle slope with the new portion of the Rue de Rivoli. The width of the new structure between the parapets is 65 feet 7½ inches, three-fifths being given up to the carriage way. The old piers were demolished down to the water, and new ones were erected on the original foundations, 11 feet 4⅜ inches in width. There are five elliptical arches, with spans varying from 61 feet 5 inches to 57 feet 0¾ inch, and in rise from 24½ feet to 23 feet 10 inches. The new bridge was erected in 1853, and the cost amounted to £28,532, to which £10,824 must be added for the cost of the quay and road at each side. The expenses were divided between the state and the city.

PONT ST. MICHEL.

The reconstruction of this bridge, which connects the new Boulevard St. Michel and the lower island, was undertaken in 1857 in order to place it in a direct line with the boulevard across the island, and to reduce the old level. Its width between the parapets is 98 feet 5 inches, the central carriage way taking up three-fifths and the side paths the remainder. It is formed of three elliptical arches of 56 feet 5 inches span. The middle arch has a rise of 22 feet 10 inches; those of the sides have a few inches less rise. The piers have a thickness of 9 feet 10 inches, and the abutments 19 feet 8 inches. The thickness of the arches at the crown is 2 feet 2½ inches. The parapets are formed of square balustrades of Jura stone. The faces of the bridge are of new

stone, but the rest of the structure was built of the old materials. The expense, including a new road at each side, amounted to £29,728, which was divided equally between the city and the state.

PONT AU CHANGE.

The old bridge which formerly stood here was demolished in 1858, in order to make a new one continuous with the boulevard across the lower island, and to enlarge the quay at the side of the Palais de Justice. The new bridge is 98 feet 5 inches wide between the parapets, and three-fifths of the width are given up to the carriage way. It is of stone, and consists of three elliptical arches, each with a span of 102 feet 7 inches, the middle one having a rise of 24 feet 2½ inches, and the others a few inches less. The arches are 3 feet 3 inches thick at the crown, and one-half more at the spring. The piers are 13 feet 1½ inch thick. The expense, including the quays, amounted to £86,599.

PONT NEUF.

The original bridge, begun in 1578, and not completed until 1604, had arrived at such a state of decay that an entire restoration was necessary. It commenced in 1848 and went on until 1855; and as the work was taken in sections, the traffic was never entirely stopped. All the exterior of the bridge is new, but the ancient style of architecture has been preserved. This bridge really consists of two, which connect the lower part of the lower island with both banks of the river. That joining the island to the right bank has a length of 486 feet 7 inches, and consists of seven arches, of which the longest has a span of 64 feet. The other part has a length of 177¼ feet. It is composed of five arches, the longest of which has a span of 55½ feet. Upon that part of the island which lies between the two bridges is the equestrian bronze statue of Henry IV. The width of the bridge between the parapets is 65 feet 7½ inches, of which 36 feet 1 inch are devoted to the carriage way. The work cost £67,471, and, in addition, £17,600 was paid to persons having rights of property.

PONT DE SOLFERINO.

This was erected ostensibly for the purpose of giving the inhabitants of the Faubourg de St. Germain easier access to the right bank of the river. It has a width of 65 feet 7½ inches between the parapets, three-fifths of which are taken up by the carriage way. It consists of three segmental cast-iron arches, having a span of 131 feet 2¾ inches, the middle arch having a rise of 13 feet 1½ inch, that of the two others being about 1 foot 5 inches less. The piers are 10 feet 8 inches thick. Each arch is supported by nine cast-iron ribs, which have a thickness of 2 feet 8 inches at the crown, and 3 feet 11 inches at the spring. The works were carried on in 1858–59, and cost about £43,600, which was divided between the city and the state.

PONT DES INVALIDES.

This was built in 1854–55 in place of a suspension bridge. It connects the Quai de la Conference with the Quai d'Orsay, and is in a line with two of the new boulevards. It is 52½ feet between the parapets, of which 32 feet 10 inches nearly are allotted to the carriage way. There are four segmental arches, two of which have a span of 104 feet 4 inches, and a rise of 10 feet 2 inches; whilst the two other arches have spans of 103 feet 7 inches, with a rise of nearly 13½ feet. They have a thickness of 3 feet 11 inches at the crown, and 5 feet 9½ inches at the spring. Two piers and the abutments of the bridge were retained. The parapets are cast iron, all the rest of masonry. The cost, without taking into account the alterations of the quays, was £42,133, which was shared in equal proportions by the state and the city.

PONT DE L'ALMA.

This new bridge establishes communication between the quarter of the Invalides and the neighbourhood of the Champs Elysées. It was begun in 1854 and completed in 1856. The parapets are separated by a space of 65 feet 7½ inches, three-fifths of which are occupied by the carriage way. There are three elliptical arches of stone, of which the side ones have a span of 126 feet 2½ inches, with a rise of 24 feet 6 inches; whilst the central arch has a span of 141 feet 1 inch, with a rise of 27 feet 0½ inch. These arches are 4 feet 10 inches thick at the crown. The piers, which are built on piles, are 16 feet 4¾ inches wide. The abutments have a thickness of 26 feet 3 inches; that of the left bank is founded on the natural soil, that of the opposite bank on piles. The cost, including the formation of quays, amounted to £83,030, which was divided between the state and the city.

In addition to these bridges, there is the viaduct of Auteuil, over which the Chemin de Fer de Ceinture is carried at the west end of the city. This is by far the largest and handsomest of the new bridges, and it is so important that we shall give a description of it in a future article.

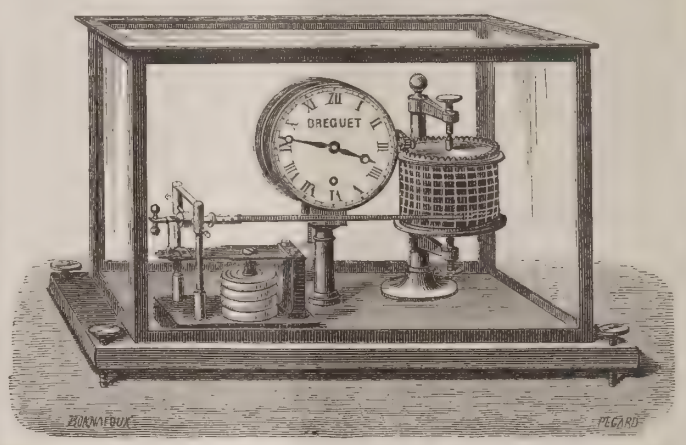
SCIENTIFIC APPARATUS AT THE FRENCH EXHIBITION.

No. I.

We propose to give from time to time some notices of the scientific apparatus which was temporarily deposited in the Great Exhibition at Paris. The collection was a good one, although perhaps there was no great novelty to be found in it. The English contributed nothing but microscopes and a few telescopes; it was to the French that the honour of the exhibition in this respect belonged. Their instruments of precision (as they call them—a much better and more extensive term than our "philosophical instruments") were numerous and excellent, and deserved a lengthened study, which would indeed go over all the principles of physical science.

BRÉGUET'S BAROMETROGRAPH.

We will begin with some instruments sent by M. Bréguet, who is widely known for his skill as a maker of telegraphic apparatus. The annexed figure represents his Barometrograph, an instrument intended to register the fluctuations of atmospheric pressure. To the top of an



aneroid barometer a steel plate is so attached, that it rises or falls with the instrument under the continually varying weight of the atmosphere. Upon one end of the plate rests the lower extremity of a short, straight, stiff wire, the upper end of which supports the indicating part of the apparatus. As the steel plate rises or falls so will the piece of wire, and so will the indicating part of the apparatus. The latter consists mainly of a long thin piece of wood bearing at one end a steel point, and at the other, where it is composed of metal, it carries a weight shaped like a dumb-bell, which induces the whole bar to fall when the sinking of the wire allows it to do so. The rest of the apparatus consists of a drum turning freely on its axis, and having a series of teeth round the upper edge of its circumference. These teeth gear into the teeth of a pinion, which is carried by an arbor moved by one of the wheels of the clock. By this contrivance the drum is carried round one revolution in the space of seven days. Around the circumference of the drum is stretched a piece of blackened paper, divided into equal spaces by vertical lines and by concentric lines. The space between any two of the latter measures one centimetre (0·394 inch), whilst the angular motion of the drum carries the paper under the marking point from one vertical line to the next in six hours. The action of the apparatus will now be easily understood. The metal point at the end of the slip of wood is kept pressed against the blackened paper, and any motion that it receives from the aneroid through the intervention of the parts already described is consequently marked upon the paper. The band of paper is removed from the drum at the end of eight days, and another one is substituted. That which is taken off, after receiving a coat of varnish, can be preserved for any length of time for future examination.

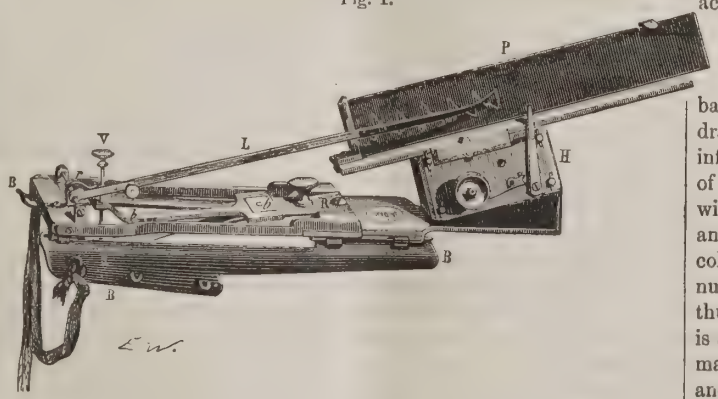
BRÉGUET'S TUNING-FORK CHRONOMETER.

The apparatus exhibited is the invention of M. Niaudet-Bréguet, who being aware that the tuning-fork has been frequently employed to measure small intervals of time, proposed to prolong its vibrations indefinitely by means of clockwork. The apparatus in question does not differ from a piece of ordinary clockwork except in the substitution of a tuning-fork for the regulator commonly employed, which, as is well known, is in clocks an oscillating pendulum, and in watches a spiral spring. It is consequently composed of wheelwork and a tuning-fork, which exert a reciprocal action on each other through the intervention of an escapement. The fork governs the rate of motion of the wheels by allowing a tooth of the escapement wheel to escape at each of its simple vibrations, whilst that wheel keeps up the motion of the tuning-fork by a small impulse given to the lever by each tooth as it escapes. The simplest mode of regulating the motion of an instrument of this kind consists in comparing the tuning-fork of the instrument with a free tuning-fork by the optical method of M. Lissajous. We can thereby test the continuousness of accord, when once established, in the vibrations of the two forks, the free tuning-fork being made to vibrate by the hand every time we are desirous of instituting a comparison. The accord is always maintained when we double or triple the moving weight of the apparatus. By placing equal and symmetrical masses upon the two arms of the fork, the rapidity of the vibrations is diminished. It is easy to imagine arrangements by which all intermediate rates of vibration can be obtained between any two given limits. The principle of this apparatus seems to be susceptible of two distinct applications—1st, It will allow us to measure very small fractions of time, and we can count the hundredths or the thousandths of a second as we can count seconds and half seconds by a common clock; 2nd, It will enable us to regulate the movement of a train of wheelwork attached to the registering apparatus of an instrument of observation, just as the motion of parallactic telescopes is regulated by means of oscillating pendulums. Consequently we can establish the synchronism of two systems of wheelwork having rapid motions—an object frequently desired in electro-telegraphy.

BRÉGUET'S MAREY'S SPHYGMOGRAPH.

This instrument, represented in the accompanying cut, is employed by physicians to ascertain the nature of the beat of the pulse. It is attached to the arm by means of a lace which is passed through eyes and round hooks in the two side pieces, B B. The spring, R R, rests upon the artery; its pressure can be regulated by means of a screw

Fig. 1.



placed near the fixed end. A bent bar, *b b*, receives the movements of the artery from the spring, R R, as they are communicated to it from the lower end of the screw, V, and transmits them to the lever, L, which both enlarges them and figures them on the paper, P. This slip of paper is carried by a metallic plate which is moved along by means of clockwork, shown at H. That part of the apparatus which is moved by the pulse is very light, and therefore motion is given without loss of time. The small spring, *r*, brings back the lever, L, to its place as soon as the lifting movement ceases. Thus the effect of the inertia of the parts is obviated, and the indications of the instrument on the paper may be taken to represent accurately the movements of the artery. In the following figures are shown some of the indications given by the instrument in four distinct diseases:—

Fig. 2. Aneurism.

Fig. 3. Weakness of Mitral Valve.

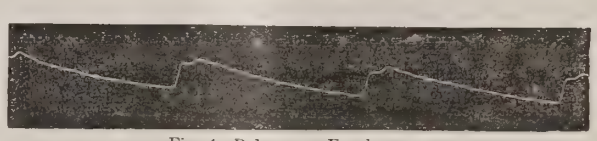


Fig. 4. Pulmonary Emphysema.

Fig. 5. Weakness of Aortic Action—Effect of Digitalis.

COLLIN'S MARÉGRAPH.

An apparatus intended to register the time of high tide and its height is exhibited by M. Collin, the well-known clockmaker of Paris, who has given it the name of Marégraph. A large brass drum is mounted on a cast-iron frame, and is made to rotate on its axis so as to make one revolution exactly in twenty-four hours. This drum has a length of 90 centimetres (2 feet 10½ inches nearly) and a circumference of 144 centimetres (4 feet 8½ inches). The edges are divided into 288 equal spaces, each representing five minutes. A sheet of paper is stretched over the drum, and upon this paper the registry is made by means of a pencil held by a chariot carried by a graduated bar above the drum. The chariot is capable of sliding from one end to the other of the bar. A cord attached to the chariot passes over a pulley at one side of the apparatus, and carries a counter weight. The same cord is passed over another pulley at the opposite end of the apparatus, and then round the axle of a wheel, round the tyre of which is passed another cord, having at its extremity the float to be thrown into the sea. The action of the apparatus, from what we have said, is not difficult to understand. As the tide rises, the float going with it allows the wheel to turn, and the cord upon its axle being thus unrolled, permits the weight at the other end of the cord of the chariot to pull it along the bar. The pencil being kept down to the paper by a spring, a line is drawn, which is the resultant of the motion of the chariot under the influence of the tide, and of the motion of the drum under the influence of the clockwork. The paper being divided by lines in correspondence with those on the bar and on the edges of the drum, the time of high tide and its height are thus registered. By employing pencils of different colours on successive days, the confusion which might result from a number of lines of the same colour is avoided, and the same paper may thus be kept on the drums for some time. The price of the apparatus is 3000 francs. Instruments similar to the one exhibited in the French machinery gallery, near the grand entrance, are at work at Quillebœuf and other places on the coast of France.

RECENT PROCESSES EMPLOYED IN THE MANUFACTURE OF STEEL.

At such a time as the present, when there are collected together at the Paris Exhibition specimens of nearly all the metals resulting from various treatments to which they are submitted under different hands—specimens both colossal as well as diminutive, arrayed to the world in all their newest dress, and in most instances discharged from the manufacturers' hands as the highest types of general excellence yet attained unto—at such a time it devolves upon us to collect together in a useful form all that is known publicly of the novelties of the art; although whilst a good deal of valuable information is lying scattered about and

wanting only to be compiled, nevertheless in some of the countries wherein the most remarkable iron and steel works in the world exist, the inquirer is barred through the effect of absurd state practices from ascertaining much that it is most desirable should be known.

We first draw our readers' attention to what has lately been effected in France, partly with the view of overcoming the difficulties which up to the present time remain adhering to the Bessemer process—the difficulty particularly which has attended the removal of phosphorus and sulphur.

One process, that by MM. Emile and Pierre Martin, has received full development in commercial operation. In it there does not, however, appear to be much of anything that is novel in theory; for although this may be the first instance in which steel has been practically produced on a large scale in such a manner, such a process has, we believe, been more than once proposed. It consists in melting a charge of pig iron in a Siemens' furnace having a trough-shaped bottom, or instead it may be first melted in a cupola and then run into the Siemens' furnace. It is thus exposed for thirty minutes or thereabouts to the action of a high temperature, after which a portion of wrought iron, scrap steel, scrap iron or iron ore, or an admixture of these, is added to the charge. Before these substances are added they are heated to redness, so that the addition of them to the molten metal may have no great cooling effect on the furnace. These additions consist of charges of about 2 cwt., and are made at intervals of half an hour up to the end of about six hours, during the latter part of which the temperature is raised as high as it is possible to get it. From this brief description it is evident that, theoretically, the process corresponds to Bessemer's, but a different system of treatment is employed in bringing about the conversion into steel. Mr. Bessemer at first completely decarbonizes the iron in a very rapid manner, and recarbonizes it afterwards by the addition of spiegeleisen in quantity sufficient to effect a combination of carbon with the decarbonized metal to produce the quality of steel sought for. Nevertheless, with all the advantages belonging to the Bessemer process, it has hitherto defied our skill to use up old scrap malleable metal in the converter in quantities anything like commensurate to the wide applications of the process itself. When we consider that our great lines of railway are some of them replacing their old malleable rails by those of Bessemer steel, when our engine-builders are using steel in all the vital parts of their structures, and replacing iron by Bessemer metal in existing machinery, we may begin then to appreciate how vast must be the stock of scrap malleable iron that must rapidly accumulate, unless some means be devised of using it up in the converter or in some analogous manner; in fact, what we want is to make Bessemer metal direct from the existing manufactured details of malleable iron which it is replacing, without first of all reconverting our manufactured malleable iron into cast iron.

So far, we understand, there never has been more than 30 per cent. of scrap wrought iron added to the charge in the converter; indeed this, we believe, was with difficulty effected, and could not have been had not the scrap (old rails) been first brought up to a welding heat. In this case the old rails were thrown into the converter, and the charge of pig iron (very gray hæmatite) instantly run upon them. In MM. Martin's process, however (which may be characterized as a slow process), the inventors state that they can easily add as much as 66·6 per cent. of old rails to 33·3 per cent. of pig iron.

From what we have now shown it will be apparent to any one conversant with the chemistry of iron, that by varying the quantities of malleable iron added to the molten pig the Martin process is capable of producing as many different qualities of metal as Bessemer's. In support of this view it should be added that MM. Martin have produced the same series of metals, containing varied proportions of carbon, that has been obtained by the Bessemer process. Tool steel of high quality, too, has been produced, as well as soft steel (homogeneous metal), and the very softest kinds of decarbonized iron, *fer fondu*, or "cast malleable iron." In addition to the makes we have mentioned, MM. Martin produce a mixed metal, part cast iron and part steel, similar to what Mr. Bessemer has employed for hammer heads and anvils.

In order to ascertain the moment at which the metal in the furnace has arrived at the condition required, its quality is carefully submitted to a mechanical test at intervals by removing small quantities of it, which are run into ingot moulds, the ingot being afterwards tried under the hammer.

At the present time the Martin process, besides being used at the inventors' works at Sireuil, is in operation at Creusot, at MM. Verdies, Firmini (Loire), and in some other continental steel works, where its results are looked upon as highly advantageous, both with regard to the quality of the steel and the general economy of the process; so that until something better is devised the process appears highly deserving the attention of home-producers. Ere leaving this first part of our subject it should be mentioned that a chief point aimed at by the inventors was in a great extent to supersede the Bessemer process, by the complete elimination of carbon, sulphur, &c. This, however, they have completely failed in doing, and, as we believe, failure to effect this will continue until some means analogous to the Richardson process, fully described* in these pages, is devised.

The next process that has come under our notice is that of M. Berard, of Paris, who has conducted his operations at Montataire; for it, however, we cannot find reason to speak in favourable terms at present, as from its very nature, unless much modified from its present mode of being conducted, there appear to be serious practical difficulties in the way. The mode which M. Berard has followed so far consists in successively decarbonizing and recarbonizing molten pig iron in a Siemens' furnace. This is effected by dividing the chamber of the furnace midway by a fire-clay slab or brick partition; in this manner the furnace is made to contain two separate charges of molten metal. By means of the Siemens' furnace arrangement the flame can be caused to act from both ends of the chamber alternately, that is, from right to left and from left to right. Supposing it, in the present case, to be acting from right to left, it is obvious that the flame must first pass over the charge in the nearest division of the chamber before it reaches the bridge, and afterwards the charge in the second chamber. The flame in passing the first division of the chamber is highly charged with oxygen, the surplus portion of which attacks the carbon and other impurities that have to be eliminated, thus converting the flame from an oxidizing condition into that of a reducing flame, and passing into the second chamber (wherein the iron is less impure) it parts with its carbon, restoring it to the molten iron in that chamber. The carbonizing effect of the flame, ere it reaches the second charge of liquid metal, is sometimes increased by placing carbon in the form of loose pieces of coke or charcoal on the bridge. The flame thus first passes over molten crude pig, after which it reaches the decarbonized mass, to which it parts with some of its carbon, converting it into steel. By reversing the direction of the flame it is evident that when in the oxidizing state it passes over that portion of the metal which had just beforehand been carbonized, again decarbonizing it, and therefore adding carbon to, or recarbonizing the charge in the next division. By these successive decarbonizations and recarbonizations, with a flame in its original state oxidizing, M. Berard gradually removes the carbon, and therefore brings the metal into the state of practically pure liquid iron, to convert which into steel he then applies a flame highly charged with gas, which therefore parts with some of its carbon to the molten metal, thus gradually altering it into the condition of steel of the nature required. The process is now arranged so that one compartment of the furnace contains nearly decarbonized metal, whilst the other contains molten pig iron. Thus, by passing the flame over the pig iron first, it becomes charged with carbon, which it adds to the purified iron in the second compartment, converting that into steel; in this manner the conversion is effected with only one change in the direction of the flame.

To the practical metallurgist it requires no explanation, that according to the quantity of surplus oxygen the flame or current of gases may contain, the time for effecting the conversion may be diminished or protracted to any desired extent, and M. Berard supposes that by extending the time he is able to get rid of the sulphur and phosphorus in greater degree than the short duration of the Bessemer process will admit of. How far in this particular direction the inventor has succeeded we have not been reliably informed; but we may add our own conviction that the long application of oxygen has nothing whatever to do with the removal of those two elementary impurities. That a very large proportion of them is, however, removed by the common process of puddling is certain, and we think the first step that should be taken to advance the solution of the inquiry would be some careful analyses of metal taken from the puddling furnace at short intervals during that process. There can be no question as to the value that such analyses would present to the iron and steel manufactures; we could thus see the exact stage at which the elimination of these substances begins and where

* Vide, *P. M. Journal*, pp. 137, 138, vol. iii., Third Series, and present part.

it stops; noting too the time and condition of the furnace at each instant a specimen is withdrawn, we could then arrive with a certainty at all the influences at work, and exact knowledge on these points would no doubt enable us so to modify Bessemer's or some other process, so that the phosphorus and iron would be ultimately separated.

We understand that Berard's process is as yet far from being in a commercial form, and that out of all the experiments that have been made but a comparatively small proportion of sound steel has been obtained.

We have next to refer to a new process for producing steel that has been brought out nearer home by Mr. C. W. Siemens. It consists in separating iron directly from its ores by the action of a reducing flame; the surplus carbon in which is raised to a high temperature by the combustion of part of the gases composing it. The carbon of the flame attacks the oxygen and other elements of the ores, raising the whole sufficiently to bring the metal into a molten state; that is, in somewhat the same state of combination as cast iron, in which condition it may be tapped. If, however, the proportion of combined carbon be less; that is, if the metal is in the condition of steel, it may be run off in this state. It is obvious that by this process iron or steel may be obtained directly from the ores, without the intervention of any of the well-nigh endless dodging and uncertainty that is attendant upon existing practised methods; all that is necessary being the introduction of a reducing or oxidizing flame at the right instant to produce the requisite quality of iron or steel. Beyond experiment this process has not yet reached. Steel in small quantities has, however, been produced by it at Mr. Siemens' works at Birmingham; a piece from this model establishment being exhibited at Paris. At the Barrow Steel Works, too, experiments on a much larger scale are going on, where a full-sized furnace has been erected, and where some of the well-known hæmatite ore has been reduced to steel by it. Thus at present it behoves us to speak with great caution on the probable prospects of this, or indeed any of the other processes equally new, although it cannot be denied that about this latter there appears something very practical-looking. Its direct results, if they can be constantly relied upon, will add much to the economy of our steel manufacture; besides, it shows that gaseous fuel may be used with safety, thus placing us probably independent of the bad qualities of some solid fuel, since the most unsuitable kinds can in the gaseous state be modified by purification before commencing to act upon the ores. For our own part, we incline to think that some difficulty will be met with in applying the process to different kinds of ores. However, from a recent conversation with Mr. Siemens on the subject, we gathered that on this point he apprehended little difficulty. We shall from time to time keep our readers posted up in the progress of these processes, amongst which it seems certain that in some shape great good must result for the iron manufacturers.—V. D.

STEEL ROPES AND DRIVING BELTS.

The ropes now manufactured for steam-ploughing purposes are possessed of great tensile strength and pliability. A contemporary says that the improved steel wire has a strength of from 160 to 175 tons per square inch of actual section; that 176 No. 14 wires have a total section of 1 square inch, and that each wire will bear 2000 lbs. to 1 ton breaking strain; and that the ropes made from these wires run readily around 4 feet or 5 feet drums, coil perfectly, and last for a long time. Such being the case, it becomes important to us to look to steel in a measure to substitute leather driving belts. Whilst the substitution of leather in this department, amongst the number, of its wide applications by other substances, such as the vegetable gums, gutta percha, and india-rubber impregnated into strips of coarse woven fabrics, has often been tried, and used, too, with a certain measure of success; speaking, as we now do, from an experiment as to the value of such a combination for driving belts, we can certainly assert that we never found them one quarter as durable as leather: their use was more costly than the older used substance. At the present time, in some of our large manufacturing towns—Dundee, for example—driving belts are used for certain light classes of machinery, woven from cotton and flax warp and weft, probably with the admixture of a little jute; and for the special purposes to which they are there applied, have answered well, until the edge begins to fray out, which commencement, of course, rapidly terminates the life of the belt; so that the accumulation of this sort of waste is becoming a serious affair, so much so, indeed, that one very large firm in Dundee, by whom much of the woven belting is used, are now devising means to use it up, and we think, too, with great probability of successful achievement.

In some, though few cases, iron and steel wire belts have been used, the pulleys on which they run being covered with buckskin or some other leather, to increase the adhesion.

We have cited these few remarks to throw out the hint that, now when cheap and strong steel wire can be purchased, there promises to be a fruitful field for inventive talent to devise some means of so weaving steel wire and gutta percha into flat belting, producing a stronger and better adhering driving band than leather ever can be.—V. D.

PARIS EXHIBITION.

RANDOM NOTICES ON THINGS GERMAIN TO *THE PRACTICAL MECHANIC'S JOURNAL.*

BRITISH HOROLOGY.

A good many of our well-known watch and clock makers exhibit—Adams, Bennett, Benson, Dent, Frodsham, Parkinson, Walker, White, and others. Most of these present both watches and clocks, and several chronometers and astronomical clocks also.

Dent's marine chronometer, with his new auxiliary compensation balance, and his fine turret clock model, with the peculiar "double three-legged gravity escapement," said to be new, and to be the invention of some amateur, are amongst the British clockwork notabilities. There are several noble French and German great clocks, and a profusion of *pendules*, or ornamental chimney-piece or sideboard clocks, whose claims are rather to beauty than exactness in time-keeping. Prussia and Switzerland, and, if we mistake not, Belgium, show remarkable displays of cheap clocks; and Switzerland asserts her usual pre-eminence in the manufacture of pocket watches, and of all the refined little machine tools, instruments, and appliances that belong to and cluster round this her national manufacture. The main clocks of the Exhibition building itself march by electricity, and in concert; the glass-dialled clock of this class over the great northern entrance is so contrived as to ring the quarters and hours by bells placed at the door and nearly on the ground.

There are many chronographs shown amongst horological instruments, none possessing, however, so far as we have seen, the interest of Captain Schultz's, which is amongst the French instruments of precision. Amongst instruments of this class, though equally belonging to "instruments of precision," we ought not to omit to notice the curious and complicated system of machines for automatic registration of meteorological phenomena, shown in the Roman States by the Padre Secchi, of the Collegio Romano at Rome. This registers at intervals, which may be fixed as longer or shorter, the direction and intensity of the wind current, the psychrometer, or state of moisture of the air, and the temperature; the state of the barometer, and some other matters. The barometer is a large iron tube with a bottle-shaped head, which floats in a cistern of mercury, and which bodily rises or falls in the cistern as the weight of its *unimmersed* mass becomes less or more; an index connected with the counterbalance marks the rise or fall upon an enlarged scale. All the instruments are recorded upon ruled papers wrapped on cylinders revolving by clockwork. The Padre has received a great medal for this combination of instruments, in every detail of each of which great ingenuity is shown.

CASTINGS.

Beautiful ornamental castings in iron are shown by Prussia, and some by other states, but none approach in excellence those which are exhibited by France. Statues, even of colossal size, others copies from the antique, figures of animals, pedestals, panels in *basso relievo*, open-work scroll grilles, ornamental columns, balusters, cantilevers, and innumerable smaller objects are shown, in most of which one is divided in admiration between the beauty of the artist's part in the performance—viz., the perfection of the model—and that of the workmanship due to the moulder, and to the choice of the iron. The whole nearly of these figures and castings are exhibited just as they left the sand, some without even the "gaits" having been cut off. Nothing can exceed the

beauty of the sanguine blue colour obtained upon the skin of these castings, nor can anything be finer than the smoothness and texture of their surfaces. Some of the figures, copies from the antique, are from subjects the least promising to be able to reproduce happily in that suggestively intractable material, cast iron, such as the Apollo of the Vatican, the Venus de Medici, &c.; yet so good have been the lines of the models, so judiciously have they been slightly altered in proportion, so as to suit this rigid character without losing their suggestion of softness, and without being distorted by contraction in cooling, that we have never seen bronze statuary more pleasing to the trained eye in its effects. Some of the animals are most meritorious creations; two large lions, for example, one *couchant*, the other sleeping, with genuine shaggy manes, real leonine expression in their faces, and covered all over with an unmistakable coat of hair, may well put to shame our gigantic shaved tom cats, with judges' wigs upon their pates, in Trafalgar Square.

In another and very different class of castings in iron, France exhibits some very satisfactory examples. Amongst these is a complete set of the water pipes for Paris, from a metre or so in diameter downwards. These are cast in great lengths in loam and vertically, some as much as 7 metres long; they are mere straight cylinders without faucets, and are put together with collars cast separately. A huge pile of these lengths are shown standing inside each other, and out of each of which a large elliptical-shaped *gobbet* has been cut, so as to show at once to the eye the relative thinness, perfect cylindricity, and absolute uniformity of thickness of the whole. Castings in bronze and brass are exhibited by several celebrated manufacturers in France. The bronze statuary and other ornamental castings of MM. Voruz, of Nantes, are highly meritorious: numbers of these, including amongst this collection fine busts of the emperor and empress, are shown just as they came from the mould, with all the "gaits" and "air vents" still adherent. Their brass castings have to the practical eye of the brassfounder perhaps even greater merit than those in bronze. The practical brassfounder knows well how hard he finds it always to preserve upon the exterior skin of his *brass* castings a perfectly uniform, unbroken, and, as it were, unfolded-over skin. Brass, at the high temperature at which it must be poured, has so intense a tendency to oxidate that it is scarcely possible to prevent an ugly film of oxidated skin from forming at the mouth of the gait, and passing into the mould, and so getting to the surface of the casting. Many an otherwise sound piece of brass casting becomes useless for "finishing up," because beneath this skin often lie concealed minute air bubbles or drossy crusts.

These French brass castings present very few symptoms of this, or of any other defect. Of brass castings for the common uses of the mechanician or plumber, &c., there are multitudes exhibited by almost every forward European nation. None are better in material than those exhibited by Germany, by Belgium, and by England. In finished brass work, such as cocks, valves, couplings, oil cups, hydrants, &c., all, in fact, that forms the trade of the great Rotherham and London houses in engineers and plumbers' fittings, none are, we think, so good, material and work considered, as those of England and Belgium. France produces much finished brass work of this sort of great excellence, but she also presents a good deal (as do some of the German states also) of brass work formed of a very soft and debased alloy of copper and zinc; one, no doubt, of a fine light gold colour, but too soft for durability. Whitley & Co., of Leeds, in company with many more, show a good deal of brass work for railway use, and have, we believe, received a silver medal.

THE LORD WARDEN.

We have compiled the following table of results of the trial of the armour-plated screw steamship *Lord Warden*, and from what is known of other vessels of that class, it will enable a fair judgment to be made of her qualities. The coefficients of performance are not as high as was looked for, when valued either by the midship section formula or that of her displacement. Some of the numerical values which it is important should be known we have not been able to ascertain with accuracy; in all such cases the division in the table is marked with a note of interrogation: we hope, however, to shortly obtain them, when we shall lay them before our readers. The date of the half power trial in 1866 we have not obtained.—V.D.

FULL POWER.

Date of Trial.	Displacement.	Immersed Midship Section.	Draught. Forward.	Draught. Aft.	Pressure of Steam in Boilers.	Load on the Safety Valves.	Revolutions of Engines per Minute at Full Power.	Horse-power, Nominal.	Horse-power, Indicated.	Rate of Steaming, being the Mean of Six Runs at Full Power.	Coefficients of Performance. By Midship Section Formula, $\frac{S^{\frac{2}{3}} \times M S^{\frac{1}{2}}}{I.H.P.}$	Coefficients of Performance. By Displacement Formula, $\frac{S^{\frac{2}{3}} \times D^{\frac{2}{3}}}{I.H.P.}$	Remarks.
Aug. 1867,	7429 "	1233 "	?	?	?	31·2 lbs.	?		6395	13·439	468	144·5	
Sep., 1867,	7839 tons	1280 sq. ft.	23 ft. 7 in.	27 ft. 9 in.	28·1 lbs.	31·2 lbs.	63·327	1000	6705	Knots. 13·496	469·26	144·66	The *Lord Warden* is 4080 tons burthen. Her engines, built by Mandslay, Son, & Field, have 3 cylinders, 91 inches in diameter; stroke, 4 feet 6 inches; cranks 120° apart; heating surface, total, 19,000 feet; grate area, 700 feet; screw, four blades, with increasing pitch, 22 feet 9 inches diameter, and a mean pitch 21 feet 4·5 inches. On this trial the draught was several inches more than intended, on account of the ship being mounted with 9-ton and 12-ton guns instead of the lighter armament originally intended.

HALF POWER.

1866, Sep., 1867,	7024 tons 7839 "	1162 sq. ft. 1280 "	? 23 ft. 7 in.	? 27 ft. 9 in.	30 lbs.	31·25 lbs. " "	? ?		5038 4080	13·139 11·777	·523·1 512·47	165·1 157·9	

LIGHTHOUSES AT THE PARIS EXHIBITION.

THERE is an almost unexpectedly large and important display of lighthouses and lighthouse appliances from various nationalities, in form of actual apparatus, models, drawings, and portfolios of photographs of existing works, at the Champ de Mars.

France in this stands first, both in the quality of her exhibits and in their magnitude. In the park stands M. de Reynaud's fine, full-sized, wrought-iron lighthouse tower of sixteen sides, swelling out towards the base and tapering up to the handsome cornice and lantern, 48·3 metres high to the gallery, and 56·15 metres to the summit of the lantern from the base. This is illuminated at night, and can be seen at many miles from Paris. The light is intended for the *Douvres* rocks, on the coast of Brittany, about halfway between the Isle of Bréhat and Guernsey, and is an eclipsing light of the first order, upon the Fresnel or dioptric system. This is the second lighthouse of iron upon this design which has been constructed by M. de Reynaud, the distinguished engineer to the administration of the Coast Lights of the French government. The first one was for the French colony of New Caledonia, and which was erected in 1865. Its tower is 45 metres high, and 50 metres is the height of the light above the high-water level. A beautifully executed model in iron is exhibited of this amongst the French government engineering models. Both these lighthouses are upon one common type: the vertical outline is something of a hyperbolic curve, above the vertical base and melon-shaped swell of the lowest part; the horizontal section is everywhere a polygon of sixteen sides. Plate-iron lighthouses hitherto have chiefly been made of boiler plate, in double or greater thickness of cylindrical shell, rivetted together in place, so that the resistance of the tower to external forces depends wholly upon this skin; the tower being in fact like a tubular bone, a hollow conoid with all its strength situated in its exterior skin.

This is beyond question the sort of construction which, when once in place, must produce the maximum of strength with the minimum of material; and so at first sight, the construction of M. de Reynaud's towers appears questionable. His construction consists in a skeleton of sixteen vertical frames of angle and T-iron, each having its plane radial to the axis of the tower (the inner T-iron being nearly vertical, the outer taking the contour of the outside of the tower), and united horizontally and diagonally by other T-iron members. These frames are united by the floors, and over the whole exterior by boiler plates, fitted into place and secured on by rivetting or bolting with lap plates outside to the iron skeleton. The whole structure is lined with brick, with a space between the lining and the iron skin. The staircase and top gallery, &c., are of cast iron; the door and windows of oak, with bronze fitments, &c. The surface plating is 0·01 metre thick at the base, and 0·007 metre at the summit, and the weights and cost have been as follows:—

	Francs.
16,880 kilos. of cast iron, at 0·40*f.*, ... =	6,752·00
47,090 kilos. of fitted castings, at 0·55*f.*, ... =	25,899·50
219,380 kilos. of wrought and plate iron, at 0·70*f.*, . . =	153,566·00
20,450 kilos. of fitted wrought-iron work, at 1·40*f.*, . . =	28,630·00
1065·50 kilos. of bronze at 6·20*f.*, ... =	6,606·10
5100 square metres of painting iron (minimum, two coats), at 0·75*f.* per metre, ... =	3,825·00
Fitments in door, windows, and sundries, ... =	2,000·00
Unprovided for expenses in the estimates found necessary during construction, ... =	22,721·00
Total francs, ...	250,000·00

The contractor was M. Rigolet.

It will be seen from this that there is more material used than would have sufficed to have made an amply strong and stiff tower had all the iron been concentrated in the *skin*. But M. de Reynaud gives the following reasons, and we think good ones, for not adopting that design. He says—1. The skin, which is exposed to the oxidation of a saline atmosphere, which *may* not be properly coated periodically to preserve it, and which under some circumstances cannot be reached to periodically coat it—is not the part of the tower in which should be concentrated all its resistance. 2. For these reasons the covering of the tower ought to be renewable, and hence it should have as it were an interior bony skeleton of iron, of such a character as to support itself, and to admit of the renewal without difficulty of the outside plating. 3. From the difficulty of erecting scaffolding, for works exposed as are lighthouse towers, and of executing handicraft work upon them at the spot for erection, the rivetting together of the multiple-plated skin becomes difficult. The interior frames then are so made that they can be put together without any scaffolding, and the plates put on by chiefly screwing up bolts and nuts, and removed in same way. 4. We thus get much more manageable dimensions in the several pieces to be put together, than we could do in the case of the whole tower consisting of a tubular skin.

There is abundant force in the first two objections; to the others we attach but little weight. There is no need of scaffolding in any case; and by proper arrangements of the parts of the skin into similar segments of plating, the whole might in very light pieces be put together and rivetted, with no more appliances than two cradles for the rivetters, and a balance crane on top, like that so well designed by the elder Stevenson for the Bell Rock light.

There is also a small lighthouse of iron for lighting the entrances to harbours, shown on the edge of the Seine. It is an octagonal tower of 8 metres in height. This is for a fixed dioptric light of the fourth or fifth order. Such towers are painted white, so that they become beacons by day.

Amongst the models of lighthouses is that of Triagoz, on the coast of La Mancha, a rectangular masonry tower, with a half cylinder projecting in the rear for the staircase. Another is the La Banche light, on the Turc bank at the mouth of the Loire, a masonry tower, much in the British lighthouse style.

The lights of Créach (Isle Douessant) and of Contis, not far from Biarritz, are shown in portfolios of designs and photographs; as is also that of Cape Spartel (Marocco), and that of Grand Rouveau, at the entrance of St. Nazaire; together with the light of La Croix, at the entrance to Trieux (Cotes du Nord). It would be vain to attempt giving detailed descriptions of these lighthouses without the aid of illustrations.

The floating light (light ship) of Ruytingen is shown both in model and in a folio of designs, and bears examination as an excellent example of its class.

From a tower of a separate building of no great magnitude in the park, near the river, are shown the arrangements adopted by the French administration for their electric lights. The light itself, in the form of a flash light, with only four seconds intervals, is exhibited every night. The electrical apparatus consists of a horizontal steam-engine, which drives the magneto-electric machine, which consists of fifty-six permanent horse-shoe magnets, distributed in seven different planes, eight in each equidistantly, and revolving before six discs, each carrying sixteen bobbins or wire coils. The maximum intensity is given by about 350 to 400 revolutions per minute, so that the current is reversed about 100 times per second. In the earlier machines of this sort, as in the English ones still, a commutator was employed. This was, by a happy idea due to Mr. Joseph van Malderen, the foreman of the Alliance Company, got rid of; and experiments made in Paris, in 1865, proved that the new arrangement was better than the old or English plan in the ratio of 100 : 55. The engine is about 6 H.P. The apparatus of the electric light itself employed, is that of M. Foucault, with certain improvements due to the well-known M. Robert Houdin.

The light at the Champ de Mars, under our observation, was of complete steadiness. Various forms of lenticular apparatus are adapted to the electric light, which can now be employed for flashing or eclipsing lights as well as for steady ones. The mean intensities of light which three different sorts have been found to afford are in the following ratio—

Flashing light, ...		13,500
Fixed light, varied by flashes,	fixed, ...	5,000
	flashers, ...	49,000
Eclipsing light, 30″ turn, ...		10,000

the unit being the usual one in France of the Carcel lamp, burning a given number of grammes of Colza oil per hour.

The light on the harbour lighthouse (at the Seine River) is produced by schist oil or petroleum; it is a dioptro-catoptric light, flashing twenty seconds, with red light and white alternately. There is one catadioptric light shown.

From the lighthouse establishment building in the park is also, we cannot say exhibited, but is made abominably audible, the French fog-trumpet, blown at regulated intervals, by air condensed by a pump worked by the same engine as that which actuates the electro-magnetic machine. This trumpet is of brass set vertically, with a right-angled

bend near the bell mouth, which thus stands horizontally, and to which a certain amount of motion (about 120°) forward and backward in azimuth is given by the attached apparatus. The pitch of the trumpet is high, and the note is intentionally made a horrible discord, such sounds being found to address the ear and the attention more fully than concords. Mr. Holmes, who is the lighthouse engineer representing the Trinity House (England), has got another of those detestable instruments at work at the temporary British electric lighthouse.

When both these fog-trumpets are at work they are perfectly unendurable. One alone is quite enough to destroy all comfort in the tens of thousands of visitors who are at the time within the same semi-diameter of the Champ de Mars. There is no earthly reason why these fog-trumpets should continue to be made to operate day after day. Every one—except Mr. Holmes and his French compeers, to whom they play the same part in the way of an advertisement, that the pipe and tabor does to "Punch"—is heartily sick of the nuisance; and it is only wonderful that the French executive, which always shows so much good sense and consideration for the comfort of the visitors to the Exhibition (always the article of *chairs to sit down upon* excepted), has not had the wisdom before this to put down the nuisance altogether.

The French exhibit also a fine set of typical forms of plate-iron buoys; some carrying bells, some beacons. There are also in model several fixed beacons, in iron and in masonry.

In the main zone of the building, collected into one spot, are the various exhibits of the English Trinity House and Northern Lights. Here we see in models, many of our own well-known and world-famous towers—the precursors and types of nearly all that has since followed them. There is the Eddystone, the Bell Rock, the Skerryvore, the Maplin Sands of iron, and a number of others, but the display is below the dignity of what England has done, and miserably incomplete. How different would have been the impression made upon the minds of foreigners as to what we really have achieved in this branch of engineering, if the whole series of our home and foreign imperial and colonial lights had been exhibited in model, and in chronological geographical order; what an interest would have attached to the beginnings of the series had good models been shown of the two wooden structures that preceded Smeaton's noble work, and had the whole vast procession of our British lights been shown, if only in photograph. Surely the "Elder Brethren" might devote enough of their large funds to such an object as producing such a set of national models, and yet have enough remaining for set dinners of turtle and champagne, toasts to lord mayors, or prime ministers, or wardens of the Cinque Ports.

Some of the most interesting of British lights are not indicated at all, even though some of the most recent. Thus, the cast-iron tower of the Fastnet Rock, designed by Mr George Halpin, jun., C.E., and executed by Messrs. Mallet, of Dublin, at once by its construction and magnitude, and by its situation—a wild over-water pointed crag, some miles out in the Atlantic, off the south coast of Ireland—is not visible or mentioned, nor indeed any other Irish light.

There is a fine display of complete dioptric Fresnel lenses for lights of various orders, remarkable in the beauty of the glass and in the perfection of figure and polish; and the clockwork apparatus of our system of revolving lights—not much besides, within the main building. Out in the park there is the lofty structure of bare heavy poles, exceeding in height everything else in the park, which the lofty ambition of "the Elder Brethren," and of Mr. Holmes, their operator, *in re* electricity, has chosen to erect. Upon top of this is perched a sort of octagonal wood bathing box, painted in alternate vertical stripes of white and green or blue, it is hard to say which of the two, and these by some preternatural ill-luck are not even vertical, but very perceptibly, though unintentionally, *slantendicular*. Upon top of this is perched a glass lighthouse lantern, and from the inside of this, *at last*, after two months' delay, now flashes at night Mr. Holmes' electric light. The light itself is ground out, in a shed at the base of the pile of poles aforesaid, from Mr. Holmes' arrangement of electro-magnetic machines, driven by a very elegant little example of the Allen engine. It is but justice to this light to say that in splendour it eclipses all other electric lights exhibited, and can be seen, it is said, on clear evenings, more than 30 miles from Paris. There is no difficulty in any amount of brilliancy in electric illumination, however; it is just as easy and as certain, to flash out a light that should strike every eye blind upon which it fell, like the lightning flash itself, as to make a spark only visible in the dark. It is a mere matter of cost. The real question is how much light per hour, measured by the photometer, is got out of the horse-power of steam energy consumed. We should be very glad to see the results of exact experiments with this end in view, which should compare the French and English systems; though we have no hope that in this, or in any other point in the entire exhibition, where accurate comparative experiments would prove of so much genuine and permanent value, such experiments, or any worthy of trust, will be made. For the present, and judging merely from the consideration of the respective apparatus, we are much disposed to imagine that the French apparatus renders a much superior *duty in light* to that of England; and such we have some reason to conclude is also the opinion of Mons. de Reynaud himself, a competent and *not* probably a prejudiced judge.

Spain unexpectedly shows, amongst the models and portfolios of her public works, a magnificent display of lighthouses, nearly the whole around her coasts, in photography, with plans by hand, and sections, and ample explanations in Spanish. We had previously no idea that the Spanish coasts and harbours were so well lighted, nor that her works of this sort were so nearly on a par with the rest of Europe. In model she shows one very large and imposing iron lighthouse, the tower mainly formed in skeleton of tubular piles or upright members at the angles of the pyramid, united by cross and diagonal ties, and having the inclosed cylindrical staircase in the centre; the living and store rooms, &c., being of iron, and inclosed within the base.

Italy also produces a highly creditable portfolio of her lighthouses.

THE PARIS EXHIBITION.

MEYER'S LOCOMOTIVES.

The problem solved by Messrs. Meyer's system, is propounded in the following terms by an eminent engineer:—

"To combine a system of locomotive of any required power, carrying its supply of water and coal, and being of the least possible weight per unit of power, that is to say, per unit of heating surface, supported by a sufficient number of axles, so that the load on each side may not exceed the minimum which the construction will admit (from 8 to 10 ton for the existing main lines; and 7, 4, or even 3 tons for branch lines with light rails); utilizing all its weight for adhesion, without, however, subjecting more than six wheels, or in some cases eight, to a common angular motion, and, finally, making the distance from centre to centre of the axles as short as possible to facilitate the passage of the engine round the sharpest curves, say, of from 150 to 100 metres radius, and even less."

This is obtained by a method of articulation, differing from that adopted in American and other engines—viz., by the division of the independent of each other and of the boiler above them, relatively driving apparatus—frames, wheels, and mechanism—into two groups, movable not only in a horizontal, but also in a vertical plane, so as to freely adjust themselves to all the variations of the line. Under these conditions, the boiler may be made of any required size without affecting the stability of the engine, and the direct and total heating surface, the surface of the grate, and the capacity of the furnace and boiler, increased according to circumstances. It also permits of the use of small coal, or coal of a cheap and inferior quality, and in any case, by the utilization of the fuel, a considerable saving is effected both in its cost and consumption for a given amount of work, whilst in the working all the economical advantages resulting from an augmentation of the load and reduced number of trains are secured at the same time that the durability of the line is increased. The construction and working of local lines with small traffic is thus rendered not merely possible but advantageous, owing to the facility of adopting sharp curves and heavy gradients with a lighter and consequently more economical road.

The Meyer system is composed of a single boiler, carried by movable trucks or bogies, ordinarily two in number, to keep within the limits of power actually useful or practicable, each of which trucks is provided with at least two axles, and if all the trucks are drivers, each is furnished with its own mechanism. The frames of the two trucks carry directly the water tanks and coal boxes, and in most cases it is desirable for the equal distribution of the weight on the wheels to arrange the water tank on the fore, and the fuel on the hind truck. The boiler does not in any way serve to transmit the tractive strain from one truck to the other, or from the engine to the wagons, it being merely supported by

the trucks without connecting them. It rests directly on the trucks without the intermedium of a special frame, by three pivot supports placed one at the front under the boiler in the vertical plane of its axis, and the two others behind at each side of the axis, also in a vertical plane, but perpendicular to the other. The front pivot nearly corresponds to the centre of the fore truck, and when there is no reason to the contrary, it should be in a vertical plane passing through the mean centre of gravity of the fore truck, that is, when the water tanks are half full, and the level of water in the boiler is at its normal height; and the other two supports are placed on the hind truck a sufficient distance apart, in the transverse plane of its centre of gravity, or as nearly so as is convenient, or as the stability and distribution of the weight of the engine will admit of—but these latter pivots are supported on the framing of the truck by shoes, under which the truck is permitted to slide, and to move freely, so that, for example, in a curve, the centre of which is to the left, the left shoe recedes from the fore truck, and the right shoe moves forward. The two trucks are united by a coupler, the front pin of which is the pivot support of the fore truck, or more correctly the socket bearing of this pivot purposely turned of a spherical form. The position of the centre of this pin, with respect to the boiler and fore truck, is thus invariable, whatever may be the relative variations in their position, since its centre corresponds with the centre of the pivot support itself. The back pin, also made spherical in form, is disposed in the centre line of the hind truck in front of its centre of gravity; it has a sufficient backward play in the parts which connect it with the truck, to permit of the two trucks being brought into close proximity, and of the two buffers with which they are provided coming in contact, the object of which arrangement is to place the coupler in the same advantageous conditions of resistance and work as that employed in connecting an ordinary engine and tender, and only to subject it to simple tractive strain. The most convenient height for the intermediate coupler is that of the buffers and coupler of the first vehicle, and it will also correspond to the height of the centre of the fore pivot. Messrs. Meyer prefer to use the Stradal apparatus for the coupler of the first vehicle.

The steam is introduced through copper pipes of the ordinary description, but sufficiently long and suitably arranged to readily adjust themselves to the relative displacements of the steam outlet and inlet orifices in the boiler, and the cylinders respectively. Experiments made on a large scale a few years since, and which are still being continued with successful results, demonstrate the efficiency of this simple arrangement. The escape of the steam is also effected in a similar manner by flexible tubes.

It will be seen that the boiler and the fore and the hind truck may be readily separated by merely unscrewing a few bolts, so that in engines constructed on this system these three main parts would be interchangeable.

The following examples will enable our readers to form an opinion of the advantages of this system in its application to the various classes of locomotives :—

EXPRESS ENGINES.

The express service is performed in France by Crampton engines, in which the heating surface does not exceed 100 square metres, and the adhesion varies in practice from 11 to 13 tons; but in engines made on the Meyer system, composed of two independent trucks each on six wheels, one pair of which in each truck are driving wheels, have about double the adhesion, viz., 20 tons—10 tons per driving axle—and from 250 to 300 metres of heating surface. They weigh on starting about 55 tons, which is distributed over six axles, say, about 14 tons less than two Cramptons with their two tenders, each Crampton engine and tender weighing about 48 tons at its departure; whilst they are capable of drawing nearly double the load of the Crampton, and maintain a higher speed for a considerably longer time, the amount of heating surface being much greater than in the Crampton engine.

A Crampton engine and tender cost 78,000 francs; the ton of traction, calculating at $\frac{1}{6}$ of the adhesive weight, amounts therefore to 42,000 francs, whilst in the Meyer engines, costing 100,000 francs, the ton of traction amounts to only 30,000 francs, thus effecting a saving of more than 28 per cent. on the purchase price alone.

A considerable economy is also realized in the working expenses consequent on the reduction of the number or increase of the weight of the trains, as well as in the flexibility and easy motion of the engine. The extreme distance between the axles of the Crampton engine is nearly 5 metres, and that between the axles subjected to the parallelism of each of the trucks of the Meyer express engines is not required to be more than 3 metres, so that the latter are capable of traversing with facility sharper curves at higher speeds than the Crampton engines.

For several years past the service of certain express trains has been performed by engines with two pairs of coupled wheels about 2 metres in diameter. The adhesive weight of these is double that of the Crampton engines, but they are not capable of dragging double the load; their maximum heating surface does not exceed about 135 square metres.

MIXED ENGINES.

The engines termed mixed have ordinarily an adhesion of from 18 to 23 tons, and from 90 to 125 square metres of heating surface, and the mixed engines on Meyer's system, composed of two trucks on six wheels, four of which are driving wheels, have an adhesion of 9 tons per driving or coupled axle, or 36 tons in all, and from 250 to 300 metres of heating surface; so that they have about three times the power, whilst possessing at the same time greater flexibility and causing less wear and tear on the permanent way.

The ordinary mixed engines cost 1 fr. 80 per. kilo. for the engine, and 1 fr. per kilo. for the tender, the total cost being about 55,000 francs; and the tractive ton, calculating at $\frac{1}{7}$ of the adhesive weight, amounts for the least powerful engines to 30,000 francs, and for the most powerful to 33,000 francs, whilst the Meyer engines, at the total price of 120,000 francs, cost only 20,000 francs per tractive ton, reckoning at $\frac{1}{8}$ of the adhesive weight ($\frac{1}{8}$ may be admitted, as the heating surface is such that a power of $\frac{1}{6}$ of the said weight may be exercised when required, and the climate is rarely unfavourable to it); so that a saving of at least $\frac{1}{3}$ is effected, without taking into consideration the further economical advantages resulting from an increased load drawn, a reduction in the number of trains, and the diminished wear and tear of the road.

GOODS ENGINES.

1.—*Ordinary engines with six coupled wheels.*

The most powerful six-wheeled coupled engines are provided with 130 and sometimes 140 square metres of heating surface; their adhesive weight varies from 33 to 36 tons, or from 11 to 12 tons per axle; their tractive power limited by their evaporating power does not usually exceed in practice 4500 kilos., and at the current price they cost with tender from 55,000 to 60,000 francs. For the same price, these engines may be advantageously substituted by Meyer engines with two independent trucks on four coupled wheels, having a less distance between the parallel axles, the maximum weight not exceeding 9 tons per axle in lieu of 11 or 12, and with the heating surface increased from 133 or 140 to 180 square metres; but Meyer's engines on two trucks, each provided with six coupled wheels, may be even more economically substituted for the ordinary six-wheeled coupled engines; the minimum adhesion being 50 tons (8 or 9 tons per axle) and their heating surface amounting to upwards of 250 square metres, which permits of the utilization of $\frac{1}{6}$ of their adhesive weight instead of only $\frac{1}{7}$ or $\frac{1}{8}$. They draw with facility double the weight, but do not cost double the price; and we may add to the saving in first cost, and the advantage of equal tractive power, all the economical advantages due to the increased load drawn, the diminished number of trains required, and the greater durability of the line.

2.—*Ordinary engines with eight coupled wheels.*

The ordinary eight-wheeled coupled engines usually have an adhesion of from 40 to 46 tons, and are provided with about 200 metres of heating surface; but their maximum tractive power does not exceed 6000 or 6200 kilos., and in fact the load drawn by these engines is disproportional to the theoretical augmentation of power, which can only be attributed to their rigidity and to the friction occasioned by the coupling together of eight wheels. The Meyer engines on two trucks, each provided with six coupled wheels, are much more powerful and at the same time more flexible and less rigid than the latter; they draw $\frac{1}{3}$ more, and cost the same for a given tractive power, whence it follows that they are much more economical.

Locomotive engines on the Meyer system are now in course of construction by the well-known firm of J. F. Cail & Co.

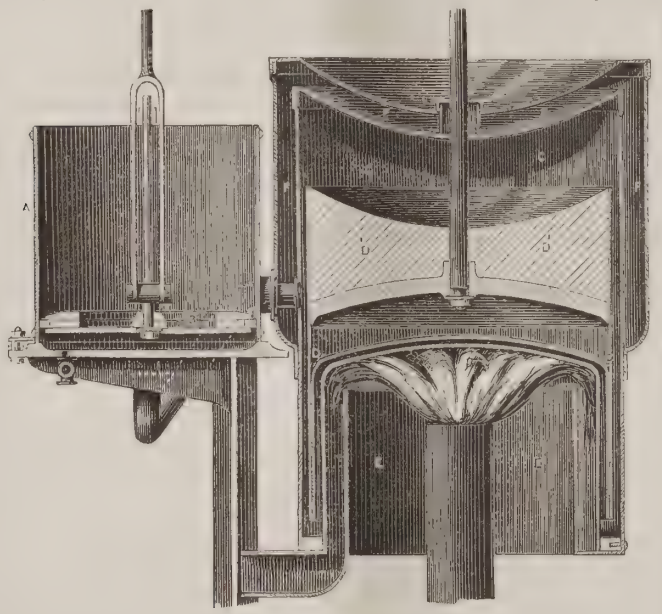
PARIS EXHIBITION.

NOTICES OF SOME SPECIALLY INTERESTING OBJECTS, &c.

LAUBEREAU'S HOT-AIR ENGINE.

THIS engine, of which we give a sectional elevation, is chiefly intended for use in works where but a small motive power is required. It consists of a cylinder, A, driving piston, B, cold-air chamber, C, movable inverted bell, D, covered at the top with a good non-conductor of heat, D', and capable of being raised or lowered in the interior of the chamber, C. E is the furnace, and F a cold-water receptacle, the water circulated by a pump, and is not necessarily changed.

In about a quarter of an hour after the fire is lighted the engine may be started. The piston, B, being at nearly the bottom of its stroke, the air-cock is closed, and the engine is moved over the lower dead centre of the crank by turning the fly-wheel, which causes the bell, D, to ascend; the air contained in the cold-air chamber, C, then descends in a thin stream around the bell, D, and enters the hot-air chamber of the same. The volume of air being doubled, it presses on all sides of the receptacle, and finding no other outlet than that leading underneath the piston, B, it acts upon its under surface and raises it to the top of its



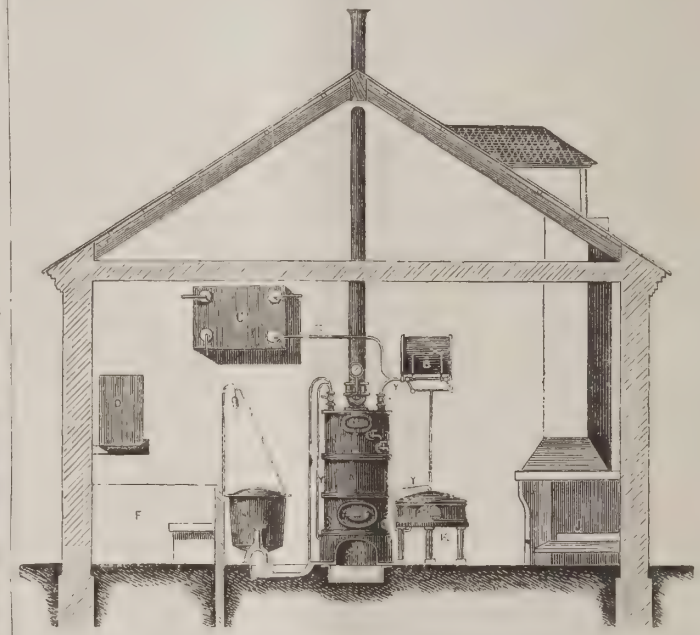
stroke, and the fly-wheel carries the crank past the upper dead centre. At the same time a cam causes the descent of the bell, D (the piston being still at the top of its stroke), which produces a vacuum of more than half an atmosphere in the cold-air chamber, C; the pressure of the atmosphere then acting on the top of the piston effects its descent, when the air contained in the cylinder, A, returns by the same conduit, and comes in contact with the cold sides of the chamber, C, and so the operation is repeated. In some of these air-engines the piston makes 500 strokes per minute. The engines have been already applied to pleasure boats, centrifugal pumps, &c.

EGROT'S STEAM KITCHEN.

The following description of an apparatus exhibited here, and recently patented by M. Egrot, for cooking by steam will be interesting to many of our readers.

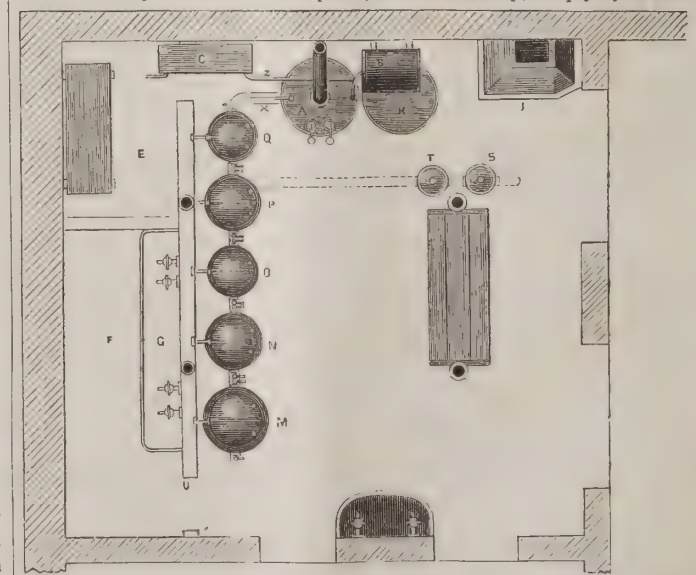
The kitchen shown in the annexed cuts is square in plan, but it may be of any other convenient shape. It is divided into three compartments, viz., the kitchen proper, the scullery, F, and the coal-hole, E. The scullery contains a sink, G, with hot and cold water cocks. In the kitchen there is a boiler, A (which we notice in detail hereafter), of 4 H.P., which, by reason of its vertical form, occupies a comparatively small space. It is fed by a reservoir, C, supplied with water by the return of condensed steam; and the steam proceeds from the boiler at a pressure of five atmospheres, that is to say, at a temperature of 153° Cent., to the culinary vessels, M, N, O, P, Q, S, T, K, placed at the right and left side of the boiler. In order to prevent loss of heat, the main steam-pipes, X, are provided with insulating jackets, and they are also placed underground for the sake of convenience.

These arrangements would, however, be incomplete if the apparatus required the same knowledge on the part of the cook or superintendent as is to be expected from an ordinary stoker; but there is provided, between the return cistern and the boiler, an hermetically-closed vessel, B, which is connected with the boiler by the steam-pipe, Y, and acts automatically, the object of which is to feed the boiler as the steam is expended. Z is the pipe which feeds the vessel, B, and *a* is a lever for actuating the cocks with which that vessel is provided. The smoke



from the boiler furnace may be conveyed into the chimney of the fireplace, J, which is used exclusively for the roasting of meat.

The vessel O', the functions of which may be said to be permanent, is a large pan of a capacity of 300 litres, into which the steam, passing through a perforated false bottom, is directly introduced, and where vegetables, fish, &c., are cooked. Water may be heated at any time as required for use, independently of the hot-water cistern, D; and the vessel may be washed in its place, when necessary, simply by means



of the steam introduced, which by its impulsive force in the middle of the vessel is sufficient to wash off and precipitate the culinary residuums adhering thereto. The admission of the steam is regulated by means of cocks placed at each side; and a woman, or even a child, can raise the hinged cover, which, like all the other vessels, is provided with a counterweight, which acts with as much ease as a suspended chandelier.

The second vessel, M, of a capacity of 600 litres, is the largest of all, and is intended for soups, boiled meat, &c.; but in this the steam does not act directly; it is introduced at a temperature of 153° Cent., or five

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Plate 12

GILLYATT'S LIQUID MANURE OR WATER DRILL,

CLAYTON, SHUTTLEWORTH & Co. MANUFACTURERS,

LINCOLN.

Third Series
Vol 3

Fig 1.

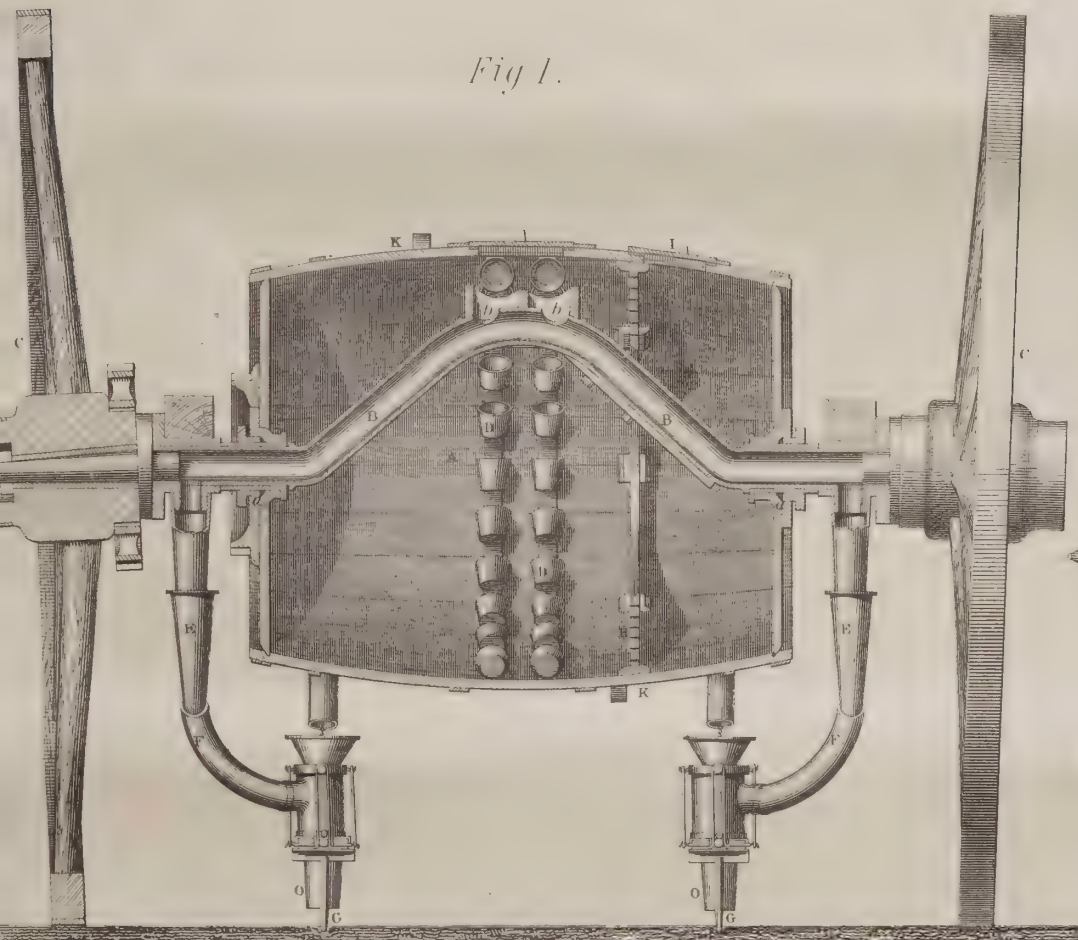
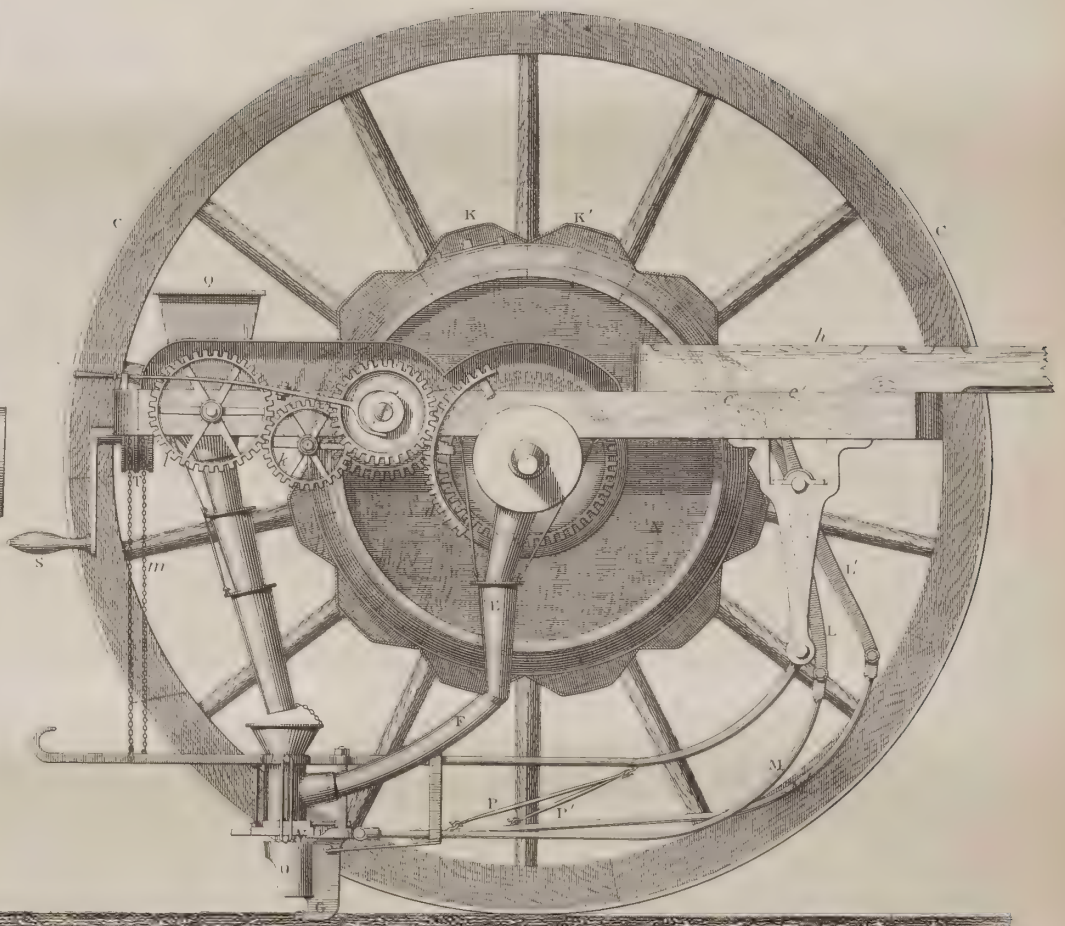


Fig 2.



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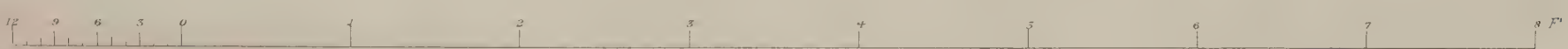

atmospheres pressure, into the annular space comprised between the external sheet-iron envelop and the internal case, which is of copper, and forms the culinary pot itself. The external envelop is provided with a jacket of thin sheet iron, which contains an insulating material to prevent loss of heat, so that the whole of the heat of the steam may be available for the purposes of cooking. When the food is sufficiently boiled, the supply of steam is instantly stopped by simply turning a cock.

It is essential, however, that we describe a remarkable action which takes place in the course of the operation, viz., that the small quantity of steam which is condensed either in the tubes or in the annular space is carried away by the superabundant steam, which causes it to ascend through a tube, also placed underground, into the return-water cistern, C, and thereby heat the water contained therein; so that when it is introduced into the vessel, B, and conveyed thence to the boiler, A, it will enter the latter receptacle at a temperature of from 80° to 90°, and in a somewhat distilled state, which prevents the incrustation of the boiler, and, at the same time, effects a saving in the consumption of fuel.

The same may be said of the culinary vessels, N, P, Q, S, T. The first, N, of a capacity of 300 litres, is destined for the cooking of stews; the second, P, containing 130 litres, is intended for the preparation of fried and roast meat; the third, Q, contains 60 litres; and the fourth and fifth, of a capacity of from 22 to 28 litres, are specially intended for the preparation of invalids' food. All these vessels may be in use either simultaneously or separately.

It will be understood that the aliments are not directly in contact with the steam, but are simply cooked by means of the dry heat which is transmitted through the sides of the internal pans, and which can neither add to the constituent water of the aliments, nor to the formation of the empyreumatic oils, which, through deficiency in ventilation, are evolved in ordinary baking ovens.

All the vessels are provided with trunnions, resting on bearings, L, L, L, L, so that they can be tilted with facility. R R are cocks disposed along the wall, against which are placed the apparatus for filling the pans intended for boiling purposes with water. On the opposite side of the boiler there is an oven, K, for the baking of bread, cakes, &c.; but in this it is requisite that the temperature be higher than is sufficient for ordinary baking. To effect this, the steam generated in the boiler is conveyed through a pipe, Y, above the fire, where it is superheated, and attains to the requisite temperature for baking in the oven.

We understand that this system of cookery has already been adopted in large establishments, and it is stated that by it the meat and vegetables preserve all their soluble parts and their nutritive qualities, whilst being at the same time more agreeable to the stomach. We should say the economy of fuel over the old system of naked fires must be considerable.

WINDMILLS.

There are several examples of this primitive but still likely to be long-continued method, of snatching for human use a fragment of the forces vibrating ever in the great cosmical machine.

At the southern end of the park, amongst the agricultural machinery, are some with jib sails, which are run out and furled automatically, at opposite sides of the diameter, transverse to the wind's direction, the motion of rotation communicated being to a vertical shaft. These horizontal windmills have nothing new and nothing advantageous about them. Not far from the grand front avenue of entrance to the park from the Pont de Jena is a very curious-looking windmill tower, with two sets of fixed vanes of small diameter, set in vertical planes at a small angle to each other, and one or both of which constantly revolve rapidly, no matter what may be the direction of the wind. This can scarcely, as to its arrangements, be made intelligible without illustrations. It is the contrivance of M. Lepaute, a clockmaker at Paris.

There are also French windmills by Bernard, of Lyons, and by Mahoudeau, of St. Epain. The most remarkable and most meritorious windmill in the whole exhibition, however, is one in the open park, in the Belgian quarter. It has got sheet iron vanes, the angles of which to the wind are changed automatically while in motion, so as to govern the speed of the motor. This is done by arrangements which are characterized at once by their simplicity and beauty. The agent for acting on the vanes is, as usual, the variable centrifugal force of two heavy balls, which fly round with the vanes. Their simple but effective connection with the vanes is the point of chief merit.—Ed.

LIQUID MANURE OR WATER DRILL.

(*Illustrated by Plate* 12.)

The useful implement which forms the subject of our plate engraving this month has been recently patented by Mr. Charles George Gillyatt, of Wickenby Manor, Lincoln, and is being extensively manufactured by the well-known firm of Clayton, Shuttleworth, & Co.

Fig. 1 of the engravings represents a vertical section of the improved liquid manure or water drill; fig. 2 is a side elevation of the drill, with portions broken away to show the more important parts; and fig. 3 is a transverse section of the barrel. The liquid and manure are inclosed in a water-tight barrel, A, which revolves freely on a bent hollow axle, B, mounted on wheels, C C, and is carried in suitable bearings, *a a*, at each end. To the inside of this barrel, at its largest diameter, there is attached a series of cups, D D, formed by preference of gutta percha, which cups, as the barrel revolves, empty themselves into openings formed at *b b*, on the hollow axle, B, at the highest part of the bend, and from thence the mixed manure flows down through the axle and through the tin tubes, E E, and flexible pipes, F F, in connection therewith to the coulters, G G, where it is delivered into the drill rows. A perforated disc, H, of gutta percha or other suitable material is placed across the interior of the barrel, A, near one end thereof, through which the superphosphate of lime or other manure, introduced into this end of the barrel through a covered opening, I, for the purpose, has to pass, thereby preventing large lumps from being taken into the pipes, and insuring also a more perfect distribution. Provision is made for delivering both the manure and seeds in patches or spots at regular intervals. This is accomplished by means of a series of projections or cams, K and K′, fixed at regular intervals round the periphery of the barrel. These cams as the barrel revolves come in contact with antifriction wheels, *c c′*, carried on the upper ends of the vertical levers, L and L′, respectively, the lower ends of such levers being connected by the rods, M M′, with slides, N N′, situated respectively in each of the drop pipes, O O′. The closing of these slides after the manure and seed has been dropped and the antifriction wheels have passed over the cams is effected by india rubber or other springs, P P′. The barrel is provided with two series of cams, K K′, made to break joint with each other, that is, to act alternately; so that as the slide in one drop pipe is being opened that in the other one is closed, and *vice versa*, the two working alternately thus giving a corresponding delivery of the manure and seed (the latter being supplied from a seed box, Q, in the rear) in diagonal rows, whereby more air and room are given to each plant. This dropping apparatus can be readily detached or thrown out of action by simply removing the springs or detaching the rods from the slides. Motion is imparted to the liquid manure barrel, A, and seed distributor in the box, Q, by the following arrangement of spur gearing:—Upon the inner side of the nave of one of the main supporting wheels there is secured a spur wheel, *d*, which gears into a smaller spur wheel capable of sliding along a feather on the carrier shaft, *f*, supported in suitable bearings in the main framing of the implement. This shaft, *f*, carries another spur wheel which gears into a spur wheel, *h*, fast on the end of the barrel, A, and imparts a rotatory motion thereto. A third spur wheel is also carried by the shaft, *f*, and gears into the carrier wheel, *k*, which transmits motion to the wheel, *l*, fast on the seed distributor. R is a clutch handle for throwing the sliding spur wheel in or out of gear with the wheel, *d*, according as the barrel, A, and seed distributor are required to revolve or remain at rest. S is a winch handle for actuating the windlass, T, with a view to raising or lowering the drills, which are suspended by chains, *m*, from the barrel of the windlass.

MECHANIC'S LIBRARY.

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RECENT PATENT.

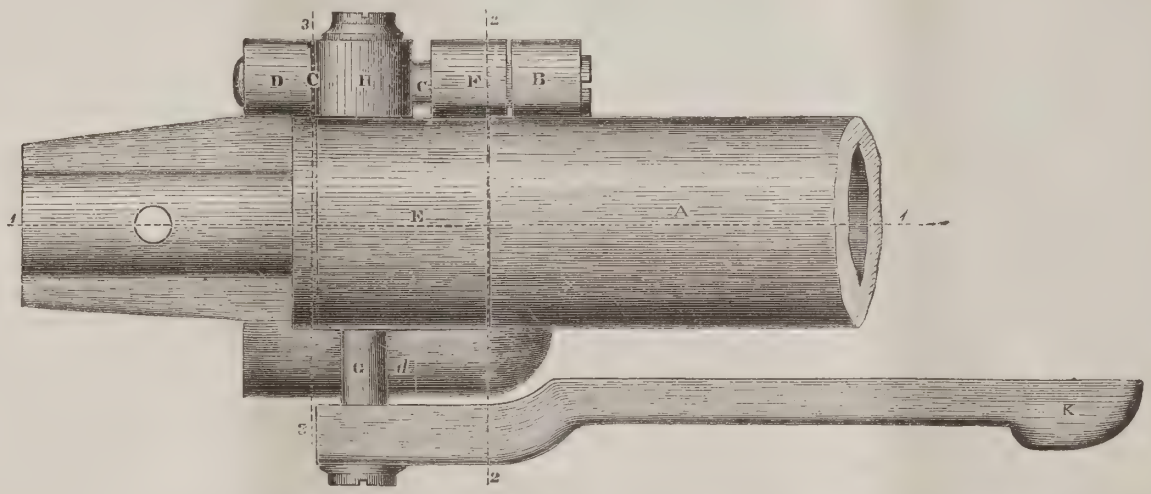
BREECH-LOADING FIRE-ARMS.

THOMAS SHEDDEN, *Ardgarton House, Argyleshire.—Patent dated 16th March*, 1867.

THE great difficulty of producing a thoroughly tight breech joint, and one that can at the same time be very rapidly opened and closed with a minimum of movements, appears now to be solved by the exceedingly ingenious arrangement recently devised and patented by Mr. Shedden.

To produce a reliably tight breech joint, it has for a long time been the practice to adapt a metallic cup, which expands at the instant of explosion, leaving the empty cup and spent cartridge case to be withdrawn by an extractor; this at all times being an operation consuming time and the exertion of another movement on the part of the person using the weapon. We believe it is Mr. Shedden's intention to adapt to his improved weapon a species of cartridge wherein the case shall be blown away, leaving the bore perfectly clear for reloading; at the same time his invention can be fitted with an extractor and used with the

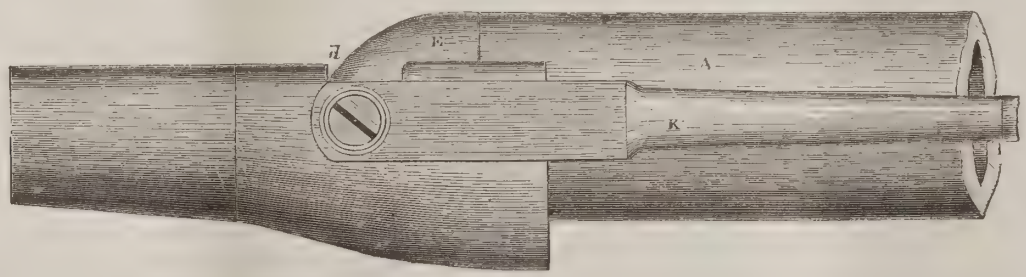
Fig. 1.



Boxer or any other ordinary cartridge. The entire arrangement will be well understood from the following description and illustrations.

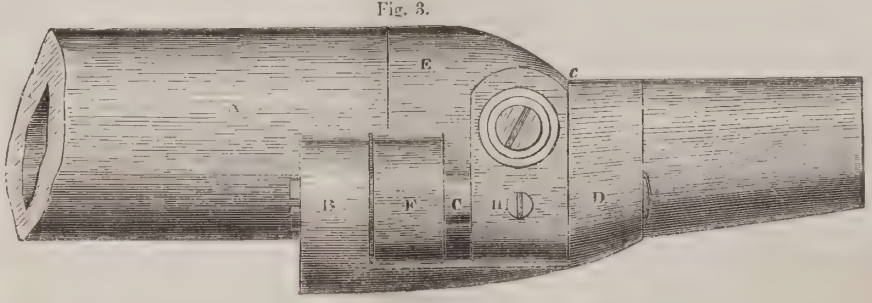
The invention, which relates to the arrangement and construction of an improved combination of mechanism whereby the breech of breech-loading fire-arms may be very effectively closed and rendered tight, consists as follows:—A lug is formed on one side of the barrel, into

Fig. 2.



direction, through which an eccentric shaft passes, one end of the eccentric shaft passing into a hole formed to receive it in a link, which is also capable of being turned round simultaneously with the breech-piece upon the horizontal stud or bar, the object of the link being to form a firm and secure bearing and attachment for one end of the

Fig. 3.



eccentric shaft. On the side of the arm opposite that to which the shutter is hinged, a metallic plate, which forms a continuation of the barrel, is provided with a recess formed in it, into which the other end of the eccentric shaft falls when the breech-closing piece is shut down, thus forming a secure bearing for the end of the eccentric shaft. A

which a stud or bar is fixed parallel to the axis of the barrel. A shutter or breech-closing piece is employed, which is secured to the stud or bar referred to by an eye projecting from it, through which the stud or bar passes in such manner that the shutter or breech-piece is free to turn thereon. The shutter or breech-piece is made of sufficient thickness to admit of a hole being formed through it in a transverse

second lug projects up at the rere end of the metallic part containing the breech-piece, into which one end of the stud or bar before referred to is fixed, and at the same time forming part of the abutment from which the breech is tightened, as after described. The eccentric shaft is provided with a lever at one end, by means of which the shaft may be turned round for either tightening or releasing the breech-shutter, in tightening which the eccentric is turned round, so as to press against the rere abutment lug, and the reremost of the two projecting pieces constituting the notch in the metallic plate, before referred to, thereby forcing the breech-shutter close against the end of the barrel. The lever for actuating the eccentric shaft may or may not be provided with a catch to retain it in position, and the breech-piece may be made with a conic or other formed projecting piece to fill the end of the barrel, or it may be made flat, thereby constituting a plane joint with the barrel. By means of the foregoing arrangements the weapon may be constructed to act with central-fire pin or ordinary cartridges; in the former case the needle would be situated at an inclination in passing through the breech-shutter, so as to be struck by the hammer against the centre of the cartridge; in the second, a recess is formed in the barrel to allow the pin to pass

through; and in the third case, a nipple is employed for the affixing thereto of an ordinary percussion cap. In connection with this invention an ordinary extractor of suitable construction may be employed.

Fig. 4.

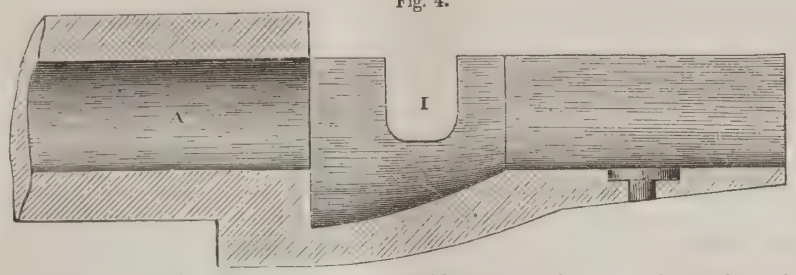


Fig. 1 of the engravings is a plan of the breech and of a barrel with the breech-closing apparatus applied thereto; the stock is not shown, as the invention may be carried out with an ordinary or other stock; fig. 2 is a side elevation corresponding to fig. 1, showing the lever, K; fig. 3 being an elevation of the side opposite to that shown in fig. 2; and fig. 4, a transverse section of the barrel and breech-piece, taken on the line 1—1, fig. 1; the remaining figures are afterwards more particularly referred to. From the barrel, A, the lug, B, projects, through which the bolt or pin, C, passes, and into which it is fixed, the opposite end of the bolt, C, being retained or held by another lug, D, projecting from the side of the breech cavity. The breech-piece, E, is attached by a lug, F, to the pin or bolt, C, through a hole in which the bolt passes; and through the rere end of the breech-piece, E, a cylindrical hole is formed, as shown at *a*, fig. 5, which is a transverse section of the breech-piece along the line 1—1, fig. 1. This hole, *a*, is for the reception of the eccentric shaft, G, shown in detail at fig. 6. One end of the shaft, G, is carried and supported in the link, H, shown also in side elevation and transverse section at figs. 7 and 8, respectively, the link, H, being capable of being rotated upon the bolt, C, which passes through the hole, *b*; it is thus obvious that when the breech-piece, E, is turned upon the bolt, C, for the purpose of opening and closing the breech, that the link, H, turns with it. In that side of the breech cavity opposite to the link, H, a recess, I, is formed, into which the projecting end of the eccentric shaft, G, falls, when the breech-piece, E, is shut down. The shaft, G, is provided with a lever, K, by which it is rotated, the rotation of the eccentric causing the advancement and effectual closing of the breech-piece, E, against the rere end of the barrel, or the withdrawal of the breech-piece therefrom, according as the lever, K, is moved through an upward or downward angle. The breech-piece has by preference a conical projection in front, as shown at fig. 5, in order that the joint with the barrel may be rendered tighter, at the same time to allow for the wear of the breech itself, as well as the eccentric. When the lever is in such position that the breech-piece is out of contact with the barrel, it is then only necessary to turn it through an upward angle, in a plane perpendicular to that of the movement necessary for the withdrawal of the breech, when the barrel is open and ready for reloading. When the breech is closed the pressure produced by the eccentric acts from the points *c* and *d*, as abutments in a forward direction upon the breech-piece itself; thus the breech-piece is supported in a solid and effectual manner. A steady pin, *e*, is put into the rear of the breech-piece, its point entering a groove, *f*, in the eccentric shaft, as shown at fig. 6. Fig. 9 is a front elevation of the breech-piece, E, showing the conical projection, *h*; and fig. 10 is an elevation rerewards; fig. 11 is a transverse section, showing the end of the barrel on the line 2—2, fig. 1; fig. 12, a section through the breech cavity on the line 3—3, fig. 1.

Fig. 5.

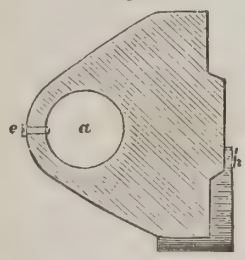


Fig. 6.

Fig. 7.

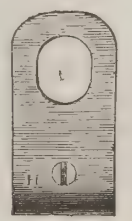


Fig. 8.

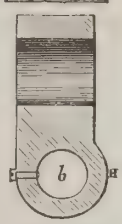


Fig. 9.

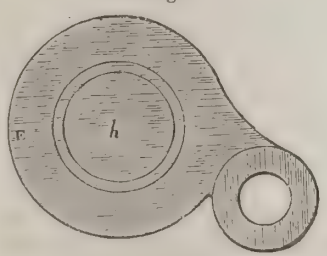


Fig 10.

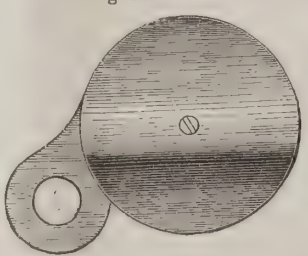


Fig. 11.

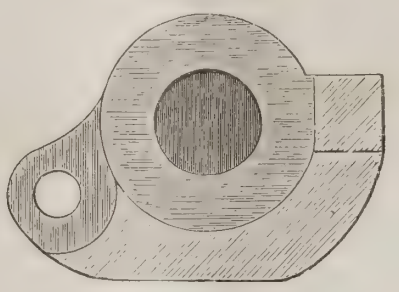
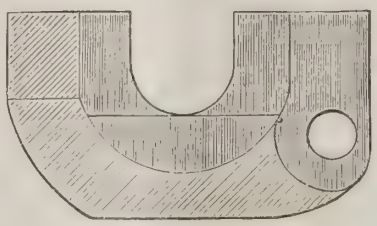


Fig. 12.



REVIEWS OF NEW BOOKS.

TRANSACTIONS OF THE SOCIETY OF ENGINEERS FOR 1866. 1 vol., 8vo., with plates. Spon, London. 1867.

THIS society, now in its thirteenth year of existence, continues to prosper, if we may judge from the number of its members, and the style of its annual volumes. The present volume, in addition to the inaugural address of the past president, which contains nothing to fix attention, embraces seven papers, all of which are of merit more or less. These are as follow:—"On the Friction of the Slide Valve and its Appendages," by Thomas Adams. "On Arched Roofs," by Carl R. von Wessely. "On the Utilization of Sewage," by B. Latham. "On the Incrustation of Marine Boilers," by Peter Jensen. "On Single and Double Rivetted Joints," by Thomas Baldwin. "Description of the Railway Bridge at the Place de l'Europe, Paris," by Thomas Cargill; and "On the Designing and Construction of Storage Reservoirs."

Whilst each one of these papers contains matter worth the perusal of even the thoroughly instructed engineer, it cannot be denied that in several of them there is a superficiality of treatment that suggests a want of more complete technical information. Thus, for example, in Mr. von Wessely's paper we find no very thorough attempt to establish a theory of arched roofs, *i.e.*, a theory of flexible arched ribs, exposed at once to thrust and to transverse strains, both local and at variable angles to the rib. Yet this has been ably treated of both by French and German mechanical writers, to whom no allusion is made.

The paper on "Marine Boiler Incrustation," in the same way, seems

to pass unnoticed much existing in Danish, German, and French works, of high value to the subject.

Lastly, Mr. Jacob's paper on reservoirs, though a very good lucid sketch of the outlines, or some of them, of the principles and practice of forming reservoirs—such as would make an excellent Encyclopædia article—is very far from embracing a great many points of the subject, which are those precisely of the most real value and interest to the practical hydraulic engineer. The subject of retaining embankments of masonry, for example, of which such immense examples exist in Spain and in France, is not touched upon; nor the beautiful theoretic investigations of Delocre in the latter country, which have fixed the modern practice in constructing this form of embankment. The degree of flexibility of embankments of earth, and the way in which such masses bend and become distorted, and finally give way, when exposed to sufficient external pressures, which have received some considerable advances lately abroad in the hands of applied mathematicians, is not even referred to. This phenomenon, the distortion of the whole mass of the embankment outside of the puddle wall, *after* the inside prismoid of the embankment up to the inner face of the puddle wall had got, by reason of its loose texture, thoroughly penetrated by water, was the inceptive cause in reality of the destruction of the Sheffield reservoir dam, as was pretty clearly shown by a writer in this journal. The failure of this reservoir is alluded to by the author, as well as the most discreditable differences of opinion amongst the "Great Gun" water engineers who were called to account for its occurrence, *on opposite sides;* but we fail to find that Mr. Jacob throws the smallest light upon what was then purposely left by others so obscure.

The papers of this volume, though good, might be a great deal better; and if this society purposes to follow close in the wake of the Institution of Civil Engineers in Great George Street, to say nothing of its more ambitious desire to get a charter of its own, it will have to bring before the world productions of still greater pith and intellectual wealth.

FOREIGN LITERATURE.

Conférences Populaires; Faites a l'Asile Imp. de Vincennes, sous le patronage de S.M. l'Impératrice, &c.

These charming little popular pamphlets are the reproductions in a form to be read by the real multitude of Paris and of France, of those popular lectures upon subjects of scientific and general interest which the Empress Eugenie has been active in promoting, as a countervailing moral force to the spread of an enervating and unwholesome flood of light literature which the *feuilletonistes* and others have poured over French society in all its ranks; but which nowhere seems to have so much needed an antidote, or rather a diversion, as amongst those of the half educated middle ranks, for whom those little neat green-covered pamphlets, each with its lecture complete in itself, are intended. The lectures were and are still in course of being delivered at intervals at the above-named institution at Vincennes, and their reproduction has been intrusted to the publication of Hatchette & Co., Paris.

Amongst the lectures already published are found—Railways, by Perdonnet; Gas-lighting, by Payen, of the Conservatoire des Arts et Métiers; the Sail, the Steam, and the Screw, by Le Clert; the Great Engineers (chiefly those of France, who as usual are here found to have made every discovery in the world, and a few besides), by Camberousse, professor of the Ecole Centrale des Arts, &c.; the Cities of Working Miners, by Simonin, mining engineer, &c.; the Californian Miner, &c., &c.; but we have given more than a sufficient list.

None of these little works propose to be profound, or *approfondir le sujet*, but they all aim at accuracy, brevity, and within their scope clearness—and they succeed in these.

Probably no one of them is so nearly a sample card of what the exactly right sort of truly popular lecture for a miscellaneous male and female audience of the middle classes should be, as that by the celebrated Daubrée, the geologist, upon "The Central Heat of the Earth."

We shall not quarrel with it because before such an audience he adopts and admits, without "hinting a doubt," the commonly accepted notion of the law of increased heat with depth as derived from the scanty and inconsistent temperatures given by wells and mines, &c.; a notion not very far from being on its last legs amongst the better informed physico-geologists of the present hour. What a difference this little lecture of Daubrée's presents to what a lecture by one of our show M.P.s in the recess time to a country English Sunday school would present? but religious *cliquerie* and knowledge must go hand in hand in England, or the latter may not go at all.—Ed.

Traité Pratique des Brevets d'Invention. Dessins, Modèles et Marques de Fabriques, Noms Commerciaux, &c. Par Is. Schmoll, Avocat, à Paris. 1 vol. thick 8vo. Baudry, Paris. 1867.

This volume is the most complete digest of the laws of patent rights, including those of designs, patterns, models, trade marks, and trade titles even, which we have yet seen. The view given (with extracts and references to the legislative enactments) of the patent and registration laws of France is complete, and, so far as laymen may judge, exhaustive; and a good deal of the information given as to the stringency with which trade marks, and even the titles of firms, the signs or designations of shops, the names of manufacturing or mercantile firms, are protected in France will, we apprehend, be in great part new to most of our readers. That is followed by a complete panorama of the patent and registration and trade mark, &c., legislation of all the countries in the world that possess such—from England to such states as Paraguay and Peru, including the small German states, such as Mecklenburg Schwerin and Mecklenburg Strelitz, &c., some of which have been gobbled up lately by Prussia, but whose patent laws, *a parte ante* at least, we must assume will remain undisturbed. The international treaties in relation to property in inventions, when such exist, are also treated of. The work ought to be in the hands of every competent British patent agent, and in those of all patentees much interested in foreign patents.

The author, in the opening of his volume, where he treats in a masterly way enough of the fundamental principles of all legislation on these subjects, boldly avows that it all rests upon the three following propositions:—1. The right of the inventor to profit by his own discovery; 2. The right of society to the use of his discovery; 3. That neither the right of the inventor shall be sacrificed to that of the public, nor the rights of the public to those of the inventor. To combine these without needless injury to either is the wise and legitimate function of all legislation that relates to invention or its results. We wonder what Lord Stanley, or his iconoclastic companions as to our patent laws, would rejoin to the clear exposition of principle here given by a French jurist to a lawyer of the same country, wherein an ignorant but not powerless section has for long held that *all* property is robbery. In some classes in England the version appears to be, all property *except mine* is robbery. However, the patent law has got a temporary respite, and this work will tend to diffuse more correct notions as to its basis before it again comes to be discussed in the hostile spirit of a year or two back.—Ed.

Neue Hinterladungs-gewehre, nach Officiellen Versuchen. Beurtheilt von Wil. von Ploennies, Gross-Herr-Hauptmann-Ritter, &c. 1 vol., 8vo. Zernin, Darmstadt and Leipzig. 1867.

This, which is no more than a thick pamphlet with a number of good, clear, and large woodcuts, comprises one of the most copious and valuable accounts we have met with of various forms of breech-loading small-arms, preceded by a discussion as to the best calibre for military arms. We have our own converted Enfields, the Spencer and Henry magazine guns, the Lindner, the Peabody, the Baden light infantry weapon, and the latest weapon of all, that of small calibre.

Our gunmakers will find this a mine of information. Unfortunately for many of them it is not translated, and the rights of translation are rigidly reserved. Our cotemporary *The Engineer* has, however, in extract given a good deal of the information this work contains. There can be no doubt of the military importance of bringing the calibre of rifles to the smallest possible point—it draws much in its rear. General Cavalli has been working successfully in this direction.

Mémoire sur la Thermodynamique. Par G. A. Hirn. 8vo. Gauthier Villars, Paris. 1867.

This is a reprint in a separate form of M. Hirn's great memoirs, experimental and theoretic, which originally appeared in the *Annales de Chimie et de Physique*, in which he treats of the dilatation and of the capacity for heat at high temperatures of certain very volatile liquids, viz., water, bichloride of carbon, sulphuret of carbon, ethylic alcohol, and sulphuric ether, regarded from the thermodynamic platform.

The work is more directly important from its abstract nature to the molecular physicist and chemist. Some of the results arrived at are the following:—

1. In the simplest of chemical combinations, the compound molecules form distinct groups in the substances which they form by their union.

2. Hence no such body can, speaking rigorously, obey in all its parts the same law of compression and of expansion.

This is one stone in the edifice now rising that promises to bind together one day, in some underlying philosophy, all the phenomena of force, we know of in the universe.

Dictionnaire des Mathématiques Appliqués, &c., &c. Par H. Sonnet, Professeur de Mécanique à l'Ecole Centrale des Arts et Métiers, &c. Hatchette & Co., Paris. 1867.

This is a new dictionary, not alone of mathematics, but of all to which "number, measure, and weight" can be through mathematics applied, of which the first fasciculus has appeared, and which is proposed being completed in nine altogether. It is upon the whole much of the same sort as the Dictionaries of Hutton, of Smith, and of several French and German dictionaries that have from time to time appeared. It is *much* superior to any of these, however, in its clear type, and in the abundance of excellent woodcut illustrations, of which one thousand nine hundred will be intercalated in the text. It is also superior in the selection of its matter, though this must in any work proposing so wide a basis of knowledge be very heterogeneous, and as a consequence, often to one who seeks the more complete sort of information very disappointing. Perhaps what would best fulfil the wants of technologists and men of science now-a-days, would be a dictionary like this in about five or six volumes, dividing the subject matter into as many great parts, such as pure and mixed mathematics; mechanics of solids, of liquids, and gases; physics; astronomy; military and nautical science, &c., &c., all in their applied aspects. What is the use of "abacus" to the soldier, or of "zodiac" to the mechanic? yet much such useless material must be turned over to come at what is wanted.—Ed.

Etudes sur l'Exposition de 1867, ou les Archives de l'Industrie au XIX Siècle: Aperçu Général Encyclopédique, Méthodique et Raisonnée de l'Etat Actuel des Arts, des Sciences, de l'Industrie et de l'Agriculture chez toutes les nations. Par les Rédacteurs des *Annales du Génie Civil*, avec Collaboration de Savans, &c., &c. Eug. Lacroix, Paris, directeur et editeur. Premier fasciculus, 15th May, 1867.

This work, announced some time past as about being produced by the enterprise of M. Lacroix, the well-known scientific and industrial publisher of Paris, has now made its appearance by its first part. It is proposed being completed in twenty parts. The array of names of the *collaborateurs* is very large and imposing, and amongst them are a few with high and justly esteemed reputations. This first part, which contains essays on the mutual relations of fine art and industry; on steam motors, including locomotives and marine engines; on horology, clocks, watches, &c., &c.—gives a fair promise that the work will prove worthy of the Great Exhibition which has called it forth.—Ed.

Physikalische Studien: Die Gesetzmässigen Beziehungen von Materie und Licht, &c., &c. Von Dr. Albrecht Schrauf, &c., &c. 1 vol. 8vo. Vienna. 1867.

This is a work of much learning, elaboration, and exhaustive labour and research, having in view the establishment of special relations between the molecular constitution of bodies of the organic class and of crystals to light. It consists of two parts, the first of which, under the head of general relations, comprises a good deal previously known, but treated under new aspects. The second part is mainly a systematic account of a special investigation, establishing numerical relations between the phenomena produced by the action of light (refraction, &c., &c.) upon special classes of bodies (organic substances and crystalline bodies), and their chemical numerical constants, and some other chemical relations; the whole leading up to the development of what the author calls "the optical atom," and nine general propositions as deductive results. The work is one of high interest to the physico-chemist, and for that class of our readers we have noticed it.

Exposition Universelle à Paris en 1867: Notices sur les Collections, Cartes et Dessins relatifs au service du Corps Impérial des Mines, réunis par les soins du Ministère de l'Agriculture, du Commerce et des Travaux Publics. Paris: Imprimerie de Paul Dupont. 1867. Pp. 346.

This work is intended to be an explanation of the series of maps, plans, and drawings contributed to the Exhibition at Paris by the mining engineers of the government, under the direction of the minister of agriculture, commerce, and public works. The notices are divided into four sections, viz.:—1. Geological maps; 2. Topographical descriptions; 3. Collections of minerals and matters connected with agriculture; 4. Miscellaneous objects. In the first section the principal object contributed is a portion of the fine geological map of France, which is being executed under the direction of M. Elie de Beaumont, who holds the office of Inspector-general of Mines. The portion exhibited represents only the northern zone of the empire, but it is sufficient to give an idea of the work, and of the excellent way in which the map is being constructed. The scale is 1 : 80,000. In the second section are comprised a number of plans of coal basins, including that large one in the north of France and in Belgium, which is about 49 miles long by 12½ broad. The scale of the plan of this coal basin is 1 : 25,000, and it is accompanied by sections, and a memoir giving details as to the beds of coal, with the results of analysis. Maps and sections of other French coal-fields have also been sent to the Exhibition, viz., those of the Pas de Calais, of the Loire and la Creuse. In the third division of the work before us we have some account of the collections of minerals which have been obtained in various parts of France. Amongst these collections is one of phosphates of lime which M. de Molon has brought together, the result of a minute and laborious search through many years. Ten years ago, we are informed, phosphate of lime was unknown in France as a fertilizing agent, but M. de Molon has discovered it in such abundance in several departments that its excavation and preparation now give employment to a considerable number of persons. A map accompanies the collection, upon which are marked the numerous localities where phosphatic deposits have been found, and likewise the spots where marls, shelly sands, and other earths abound, which are likely to be useful to agriculturists. In the fourth division of the work under review we find a minute account of the arrangements of the new laboratory of the School of Mines at Paris; descriptions of the exhibited agronomic maps, that is, maps indicating the mineralogical composition of the superficial soils of certain localities, the environs of Paris, for example; descriptions of the lithological maps of the seas of France, of Europe, and of the United Kingdom. These maps have been prepared to show the results which have been obtained by the soundings of hydrographical engineers, and by naval men, who have ascertained not only the depths of the sea, but also something of the nature of the rocks which form its bottom. We cannot but think, however, that a good deal of conjecture must be mixed up with facts in the preparation of such maps, because the rocks *in situ*, forming the true bottom, must be very frequently covered over by a more or less thick coating of loose matter derived from the degradation of the neighbouring shores. These maps have been constructed by Professor Delesse, of the School of Mines.

Exposition Universelle de Paris de 1867: Notice sur l'État des Travaux Publics en Espagne, et sur la Législation Spéciale qui les régit. Traduit de l'Espagnol. Pp. 135. Madrid: 1867.

Although one of the most backward nations of Europe, it must not be supposed that Spain has not felt the influence of the spirit of improvement, and the pamphlet before us enables us in some measure to judge of the progress she is making. Branded as she is with the disgrace of dishonest insolvency, most people will be surprised to learn that she has succeded in raising or in borrowing money sufficient to enable her to complete about 3200 miles of iron way. England wisely held back, and did not choose to risk more of her money in that land of ignorance and superstition: it is the French who are the chief sufferers, for it need hardly be said that the railways make very inadequate returns on the sums expended. Notwithstanding this about 1200 additional miles of railway have been projected; when they will be completed is not very certain. The Spanish lines have been by no means cheap lines; the nature of the country forbade that. Spain is a great promontory formed

of a series of steppes or elevated platforms, having a mean height of 1700 or 1800 feet above the level of the sea, near which they end in steep slopes. These slopes are more precipitous on the eastern than on the western coast, and it is towards the latter that the land inclines, as is proved by the course of the principal streams. The elevated platforms we have spoken of are in some cases bounded, and in others intersected by short, but sometimes very elevated, chains of mountains without any settled direction, and thus it happens that the larger valleys are destitute of the regularity, width, and gentle slope of the great valleys of central Europe. It will be evident from what has been said that considerable difficulties have to be encountered in the construction of the main lines of railways, which have to pass from steppe to steppe, or to descend from the interior to the coast.

To the importance of one class of public works Spain has been creditably alive. We refer to lighthouses, of which she has built no fewer than 157 on her coasts, and ten more are either in course of construction or in contemplation. Drawings of most of these, with sections and in some cases models, have been sent to the Exhibition. Amongst the models that of the lighthouse built on the islet of Bada, at the mouth of the Ebro. The original has an iron tower which rises to the height of nearly 174 feet. This iron work was made in England, but from the designs and under the direction of Spanish engineers, as they are careful to tell us. Of so much importance do they consider this lighthouse, that extraordinary care has been bestowed on the model to make it the miniature *fac simile* of the original, and two machines were specially made for its construction.

In a hot climate like that of Spain the supply of water, both for the consumption of inhabitants of towns and for purposes of irrigation, is of the first importance. Comparatively little, however, has been done in this direction. Various models, plans, and drawings, illustrate the recent works of this class. The most remarkable among the works for supplying water to towns is that which brings water to Madrid by a canal about 47 miles long. It has been constructed on the Roman system, that is, with stone aqueducts covered in by vaulting. By its means 200,000 cubic metres of water are daily brought to the city, but five-sixths of that quantity are employed in irrigating the country around Madrid, leaving about 22 gallons for each inhabitant of the city. The works comprise thirty-one tunnels and thirty-two aqueducts, and the cost of the whole amounted to upwards of £2,300,000.

De la Houille dans le Royaume d'Italie. Par Le Chev. C. Montagna, Off. Sup. de l'Artillerie, &c. One vol. thin 8vo., with Lithographs. Loescher, Turin; Masson, Paris. 1867.

The aim of this apparently learned, but, from the little we have remarked, not very impartially written geological work, is to prove that much yet remains to be ascertained with respect to the coal formations of Italy; to throw much doubt upon the commonly received, we may say, the so far undisputed, notion that all the coal of Italy is lignite, *i.e.*, tertiary coal, and lying far above the true coal measures; and to support this view by appeals to comparative experiments with these lignites as against Newcastle coal, which appear to us wholly illusory.

It may be, and we believe it is, a fact that the coal riches of Italy have been as yet most imperfectly examined; and it may be that tertiary coal as good as any in the world may yet be found there. It is perhaps even possible, in the existing dearth of any exact topographical geology of the greater part of the Italian peninsula, that somewhere or other the true carboniferous limestone and the coal measures, of which it is the index, may show themselves, though we deem the probability an extremely remote one; but it seems useless to endeavour to raise doubts as to whether the known lignites are tertiary coals or not.

The whole work has an air of special pleading about it, not quite unusual in Italian works which have a final, and that an industrial, aim in view.

The credibility, or at least the sound judgment, of the author is shaken too in our estimation by some hardy statements as to his certain discovery of traces of organized beings in granite, syenite, gneiss, mica schist, graphite amphibol, cipolino, emery, quartzose-steatite, and diorite. For proofs of these, which surpass all Laurentian wonders, he refers to his work "Sugli Organizzati delle rocce dette Azoiche, e Sulla Doppia Origine del Granito. Torino. 1866. Loescher." The work has been partly translated into French from the original MS. by L. Hawerman.—Ed.

CORRESPONDENCE.

☞ We do not hold ourselves responsible for the views or statements of Correspondents.

MELTING OF PIG IRON.

(To the Editor of the Practical Mechanic's Journal.)

Sir,—We are subscribers to your journal, and know that you take great interest in the melting of pig iron. We shall be glad if you can inform us what is the best means of doing away with the strong sulphurous smell that proceeds from the cupola; we use the best coke made in this district; the gas varies in quantity, but at the best is very injurious. We also much wish to know what is the best and most economical way of melting cast-iron borings. If you can reply to these two questions in your next issue, we shall be much obliged.

Yours respectfully,

Bolton, D. & B.
September 30, 1867.

[The sulphurous acid vapour, of which our correspondents complain, may come either from the coke or the pig iron, or from both; but most probably from the former. The *best* way of getting rid of it is to employ pure coke, *i.e.*, coke made from coal not rich in pyrites, for in thus becoming free from the annoyance of the smell the quality of their castings will become improved at the same time. A process was patented, we believe, by Dr. Grace Calvert for taking up the sulphur in coke by salt or soda, thrown into the cupola; we doubt that it would prove effective. Iron borings, when small, are hard to melt, and scarcely worth the trouble. Thrown in loosely into the cupola, they blow away with the blast, and are partly burnt into oxide, which may or may not be again reduced, according to the management of the cupola. Were we required to melt up a large amount of cast-iron borings, we should attempt it by mixing the borings on a floor into a sort of paste with lime in powder, salt cake, *i.e.*, crude soda, and ground coal, and then making the whole into bricks, and in that state charging them into the cupola. Mixture with coal tar and powdered lime might also answer. We have the strongest doubt, however, that any process for melting borings, unless some hundreds of tons are to be operated on, could possibly be made to pay, at the existing price of British pig iron.—Ed.]

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Dundee, 1867.

The following is a list of the papers read in the sections A, B, F, and G:—

Thursday, September 5.

Section A.—Mathematical and Physical Science.

W. R. Birt—Report of Lunar Committee.

J. Glaisher—Some Remarks on the Original Objects and General Work of the Lunar Committee.

J. Clerk Maxwell—On a Real Image Stereoscope, with Illustrations of Solid Geometry.

Balfour Stewart—On the Behaviour of the Aneroid Barometer at Different Pressures.

Sehnor Capello—A comparison of the Kew and Lisbon Magnetic Curves during the Disturbance of February 20–25, 1866. Communicated by Dr. Balfour Stewart.

Rev. R. Harley—On a Certain Cyclical Symbol.

James Lindsay (the late)—Proof of the Binomial Theorem. Communicated by W. B. Grant.

F. W. Moffatt—On Meteorological Observations at Sea. Communicated by Dr. Moffat.

J. Moffatt, M.D.—Experiments on the Luminosity of Phosphorus.

Dr. T. L. Phipson—On the Phenomena which occur when Magnetized Steel is Dissolved in Acids.

Section B.—Chemical Science.

President's Address.

A. R. Catton—Report on the Synthesis of Certain Organic Acids.

A. R. Catton—On the Synthesis of Formic Acid.

J. A. Wanklyn and R. Schenk—On the Synthesis of Caproic Acid.

J. A. Wanklyn—Action of Sodium on Valerianic and similar Ethers.

P. T. Main and A. R. Catton—On a new Synthesis of Ammonia.

J. Spiller—On the Decay of Stone.

W. Weldon—On the Regeneration of the Oxide of Manganese.

Section F.—Economic Science and Statistics.

The President's opening Address.

Report of Committee on Uniformity of Weights, Measures, and Coins.

James Yates—Reasons why the Office of Warden of the Standards should include Standard Weights and Measures of the Metric System in addition to those of the Imperial Weights and Measures.

Sir John Bowring—On Productive Labour in Prisons as associated with the Reformation of Criminals.

James Oldham—On the Utilization or more Profitable Employment of Male Convicts.

Section G.—Mechanical Science.

President's Address.

Report of Steamship Committee.

J. V. N. Bazalgette—On an improved "Tourists'" or "Local Topographical Indicator."

Joseph Mitchell, C.E.—On the Construction and Works of the Highland Railway.
John Fernie—On the Iron and Steel at the Paris Exhibition.
David Greig—On Steam Cultivation.

FRIDAY, SEPTEMBER 6.

SECTION A.—MATHEMATICAL AND PHYSICAL SCIENCE.

J. Glaisher—Report on Luminous Meteors.
Sir D. Brewster—On the Colours of Soap Bubbles.
Sir D. Brewster—On the Figures of Equilibrium in Liquid Films.
Sir D. Brewster—Notice respecting a Haystack struck with Lightning at Dun, in Forfarshire.
Dr. Everett—On the Results of Observations of Atmospheric Electricity at Kew, and Windsor, Nova Scotia.
W. Ladd—On a Dynamo-magnetic Machine.
W. Ladd—On a Magneto-electric Machine.
Sir W. Thomson—Electric Machines founded on Induction and Convection.
Professor Rankine—On the Approximate Drawing of Circular Arcs of Given Lengths.
Rev. R. Harley—On Finite Solutions of Algebraical Equations.
Hon. J. Cockle—On the Inverse Problem of Coresolvents. Communicated by Rev. R. Harley.
A. Claudet—A New Fact of Binocular Vision.
A. Claudet—On a Mechanical Means of Producing the Differential Motion required to Equalize the Focus for the Different Planes of a Solid.

SECTION B.—CHEMICAL SCIENCE.

Lauder Lindsay—On the Present Uses of Lichens as Dye Stuffs.
J. Alfred Wanklyn—On the Existence of Putrescible Matter in River and Lake Waters.
Dugald Campbell—A Note on Messrs. Wanklyn, Chapman, and Smith's Method of Determining Nitrogenous Organic Matters in Water.
A. E. Fletcher—On an Ether Anemometer for Measuring the Speed of Air in Flues and Chimneys.
A. E. Fletcher—On a Self-registering Perpetual Aspirator.
G. Ansell—On an Apparatus for Indicating the Pressure and Amount of Fire Damp in Mines.
Professor Lawson—Notes of the Analyses of Gold Coins.

SECTION F.—ECONOMIC SCIENCE AND STATISTICS.

Professor Leone Levi—On the Condition and Progress of Scotland in Relation to England and Ireland in Population, Education, Wealth, Taxation, Crime, Consumption of Spirits, Savings Banks, &c.
Report of the Committee on the "Uniformity of Weights, Measures, and Coins" (so far as it relates to Coins).
Frank P. Fellowes—On the various Methods in which our Coinage may be Decimalized; the Advantages and Disadvantages of each.
Henry J. Ker Porter—On the Prevalence of Spedalske or Leprosy in the Kingdom of Norway.

SECTION G.—MECHANICAL SCIENCE.

Rev. Patrick Bell—On Reaping Machines.
Professor J. Clerk Maxwell—On the Theory of Diagrams of Forces as applied to Roofs and Bridges.
George Fawcus—On the Stowage of Ships' Boats.
George Maw—Covered Life Boats.
Professor Macdonald—On the Construction of the Life Boat.
John Halliday—On the Heating of Hot Houses.
William Paterson—On the Consumption of Fuel.
J. D. Everett, D.C.L.—On the Rigidity of Glass, Steel, and Brass.

MONDAY, SEPTEMBER 9.

SECTION A.—MATHEMATICAL AND PHYSICAL SCIENCE.

G. J. Symons—Report of the Rainfall Committee.
Alexander Brown—Observations of the Rainfall at Arbroath.
John Thruston—On Evaporations from Rain Gauges.
Colonel Sykes—On Storm Warnings, their importance and practicability.
George Forbes—On the Meteor Shower of August, 1867.
Sir D. Brewster—On the Colours of Films of Alcohol.
Sir D. Brewster—On the Radiant Spectrum.
Sir D. Brewster—Notice respecting Mr. Macrae's Photographs upon Glass and Porcelain.
A. Claudet—Photographic Portraits obtained by Single Lenses of Rock Crystal and Topaz.

SECTION B.—CHEMICAL SCIENCE.

A. Crum Brown—Remarks on the Calculus of Chemical Operations.
Maxwell Simpson—On the Formation of Succinic Acid from Ethylidine.
Maxwell Simpson and Gautier—On a Compound formed by the direct union of Anhydrous Prussic Acid and Aldehyde.
A. R. Catton—On Loewig's Researches on the action of Sodium Amalgam on Oxalic Ether.
I. Lowthian Bell—On a method of recovering Sulphur and Oxide of Manganese, used at Dieuze, near Nancy, France.
J. H. Gladstone—On the Refraction Equivalent of Salts in Solution.
J. Spiller—On certain New Processes of Photography.
W. Crookes—On a new Polarizing Photometer.

SECTION F.—ECONOMIC SCIENCE AND STATISTICS.

Alex. J. Warden—On the Linen Manufacture of Dundee.
James G. Orchar—On the Engineering Trade of Dundee.
Henry Gourlay—On the Iron Shipbuilding of Dundee.
James Yeaman—On the Seal and Whale Fisheries of Dundee.
Frank Henderson—On the Leather Manufacture of Dundee.
C. C. Maxwell—On the Confectionery and Marmalade Trade of Dundee.
A. Robertson—Statistics of the Social Condition of Dundee.
E. Renals—On Arbitration in the Nottingham Hosiery Manufacture.
Dr. Lauder Lindsay—On the Obstacles to the Utilization of New Zealand Flax.
A. Stephen Wilson—On the Measure and Value of Oats.

SECTION G.—MECHANICAL SCIENCE.

Report of the Committee on the Patent Laws.
William Fairbairn, C.E., LL.D., &c.—Report on Experimental Researches on the Mechanical Properties of Steel in its present Improved State of Manufacture.
G. B. Galloway—On the Application of the Funds derived from Patent Fees.
General Haupt, U.S., America—On the Application of Machinery to Boring and Tunnelling.
Dr. C. Le Neve Foster—An account of Bergstroem's Boring Machine used at the Preseberg Mines, Sweden.
Joseph Mitchell, C.E., F.R.S.E.—On a New Mode of Constructing the Surface of Streets and Thoroughfares.
Latimer Clark, C.E.—On the Birmingham Wire Gauge.

TUESDAY, SEPTEMBER 10.

SECTION A.—MATHEMATICAL AND PHYSICAL SCIENCE.

C. Meldrum—On the Meteorology of the Mauritius.
C. Meldrum—On the Hurricanes of the Indian Ocean.
F. Jenkin—Report of the Committee on Electrical Standards.
J. P. Joule—Determination of the Mechanical Equivalent of Heat, from Experiments on the Heat Evolved by Currents of Electricity.
C. W. Siemens—On a Resistance Measurer.
J. Jenkin—On a Modified Form of Siemens' Resistance Measurer.
C. Hockin—Examination of the Permanency of the Standard Resistance Coils to be deposited at the Kew Observatory.
Sir William Thomson—On a Series of Electrometers for Comparable Measurements through great range.
W. Hooper—On the Electrical Induction of Hooper's Insulated Wires.
Thomas Stevenson—Notice of a proposal to Illuminate Beacons and Buoys at Sea by Electricity conveyed by Submarine Wires connected with the Shore.
T. Archer Hirst—On the alleged Correspondence between Newton and Pascal recently communicated to the French Academy.
Sir David Brewster—On the alleged Correspondence between Pascal and Newton. (The letters of Newton were exhibited.)
Sir William Thomson—On Volta-convection by Flame.
Sir William Thomson—On a Self-acting Electrostatic Accumulator.
Sir William Thomson—On a Uniform Electric Current Accumulator.
Bierens de Haan—On a Theorem in the Integral Calculus.
B. Davis—A list of 5500 Prime Numbers.
A. R. Catton—On the Laws of Symmetry of Crystalline Forms.
A. R. Catton—A Contribution towards the Expression of the Angle between the Optic Axes of a Crystal in terms of the Angles between the Faces.
A. R. Catton—On the Theory of Double Refraction, with special reference to the Influence of the Material Molecules on the Propagation of Light in Crystals.
N. de Khanikof—Experiments for the Verification of the Law of Henry and Dalton on the Absorption of Gases by Liquids.

SECTION B.—CHEMICAL SCIENCE.

I. Lowthian Bell—On the Present State of the Manufacture of Iron in Britain, and its position as compared with that of some other countries.
J. B. Lawes and J. H. Gilbert—Preliminary Notice of Results on the Composition of Wheat, grown for Twenty Years in succession on the same Land.
R. F. Smith—On the Gaseous Products of the Destructive Distillation of Hydrocarbons, obtained from Shales and Coals at Low and High Temperature.
P. Spence—On the Economization of the Sulphurous Acid in Copper Smelting.
W. L. Scott—On the Bisulphite of Calcium as a Preservative of Animal Substances.
W. L. Scott—Note on the Artificial Production of Oil of Cinnamon.
T. T. P. Bruce Warren—On the Electrical Resistances of the Fixed and Volatile Oils.

SECTION F.—ECONOMIC SCIENCE AND STATISTICS.

Professor E. T. Rogers—On the Funds available for Developing the Machinery of Education.
Colonel Sykes, M.P.—Analyses of the Report upon the State of the Empire of France, presented to the Senate and Legislative Body, February, 1867. (*Exposition de la situation de l' Empire, presenté au Senat et au Corps Legislatif. Fevrier*, 1867.)
Dr. Cuthbert Collingwood—On the Consumption of Opium.
P. H. Thoms—Observations on Community of Language, and Uniformity of Notation, Weights, Measures, and Coinage.
P. M. Tait—On the Population and Mortality of Calcutta.
Patrick Matthew—Employer and Employed—Capital and Labour.

SECTION G.—MECHANICAL SCIENCE.

James K. Caird—On an Iron Camb for Power Looms.
Admiral Sir E. Belcher, K.C.B.—On the Methods for Testing the Speed of Vessels over the Measured Mile.
James R. Napier, F.R.S., and W. J. Macquorn Rankine, C.E., LL.D., &c.—On Movable Seats for Slide Valves.
Ferdinand Kohn—On Iron and Steel at the Paris Exhibition.
R. Lewis—On an Improved Marine Steam Boiler.
J. Eckersley—On J. R. Swan's Improved Calcining Kilns.
S. J. Mackie—On Iron Floating Forts, Iron Harbours, and other Floating Structures; and on Daft's Method of Construction of Iron Fabrics.
A. S. Hallidie, C.E.—On an Improved Suspension Bridge.
Professor Macdonald—On an Improved Paddle Wheel.

William Hooper—Electrical Induction.

W. W. Urquhart—On some of the Difficulties the Scientific Engineer meets with in practice.

WEDNESDAY, SEPTEMBER 11.

SECTION A.—MATHEMATICAL AND PHYSICAL SCIENCE.

C. Wheatstone—On a New Telegraphic Thermometer, and on the Application of the Principle of its Construction to other Meteorological Indicators.

Major Tennant—On Preparations for Observing the Total Solar Eclipse of August 18, 1868.

R. Russell—On some Deductions by Dr. Tyndall from his recent Experiments regarding the Radiant and Absorptive Properties of Vapour in the Atmosphere.

ROYAL UNITED SERVICE INSTITUTION.

ON THE ECONOMY OF FUEL, COMPRISING MINERAL OILS.

By Professor W. J. MACQUORN RANKINE, C.E., LL.D., F.R.S., &c.

THIS paper contains no new principle, nor any new series of experimental researches. It is an attempt to state in a compendious shape the scientific principles that regulate the economy of fuel—a shape in which they may be conveniently applied to any experimental data that now exist, or that may hereafter be obtained.

In the first place I shall have to make a few preliminary remarks on the most convenient way of expressing quantities of heat for such purposes as the present. For purely scientific purposes, the ordinary unit of heat is so much heat as raises by one degree the temperature of the unit of weight of water, whatsoever the unit of weight may be. In British measures, the ordinary unit of heat for scientific purposes is the quantity of heat which raises the temperature of one pound of water by one degree of Fahrenheit's scale—say from the temperature of 39° Fahr. to that of 40° Fahr. When we say that during a certain process—the burning, for example, of one pound of a certain sort of fuel—so many units of heat are produced, we mean that by means of that process, if there be no waste of heat, so many pounds of water have their temperature raised by one degree.

I have here made a memorandum as to the ratio of the British unit and the metrical or French unit, because the employment of French measures for scientific purposes is so common that it is important that their relation to British measures should be borne in mind, especially now that their use is permissive in this country.

One degree Centigrade = 1·8 degree Fahr.;
One kilogramme = 2·2046 lb.;
therefore, one French unit of heat = 1·8 × 2·2046 = 3·968 British units.

Connected with this mode of expressing quantities of heat, is the mode of measuring such quantities in delicate scientific experiments; and that is by the instrument called the Water Calorimeter, where there is a certain mass of water, and a process is performed, such as burning a certain quantity of combustible substance, and the temperature of that water is raised. Then, knowing how many pounds of water there are in the calorimeter, and knowing how many degrees its temperature has been raised, we can calculate the quantity of heat which that water has received. That is a process which, simple as it may look at first sight, requires great care and delicate apparatus to insure accuracy. There is one circumstance that is a fruitful source of inaccuracy, or would be so but for the precautions that are used to avoid it; and that is, the temperature not being uniform throughout the different parts of the mass of water. We have a vessel containing a certain quantity of water; we have a thermometer at one point in that vessel, and that thermometer shows a certain temperature. But the temperature in other parts of the vessel may be quite different. It is necessary, therefore, that the water calorimeter should be provided with an "agitator," like a screw propeller, for stirring or mixing all the particles of the water intimately together, and for insuring so constant a circulation in every part of the calorimeter, that the whole of the water shall be at one temperature.

Then there are always certain causes of waste of heat at work. The water in the calorimeter loses heat by conduction, and heat is carried off by the escape of the hot gases produced by the combustion; and the losses of heat which thus occur have to be measured and to be allowed for.

The measurement of heat, then, by the calorimeter is suitable for a scientific laboratory; but on account of the minute precautions that it requires, it can scarcely be considered practicable in such a way as to be trustworthy in experiments on a great scale.

As an instance of the way in which errors may arise in that mode of measuring heat, suppose that we have a certain boiler containing water, and that we apply some heating process to that water until the bubbles of steam begin to come from it under the ordinary atmospheric pressure. We should run a risk of serious error if we assumed that the whole mass of water was at the boiling point. The upper stratum of water may be at that temperature, and may be giving out bubbles of steam, but the lower strata of the water may be at lower temperatures; and we may be led to form most erroneous estimates of the quantity of heat given out during the process if we conduct the experiments in such a manner as that.

For practical purposes, connected more especially with the steam-engine, the most convenient unit of heat appears to be the *unit of evaporation;* that is, so much heat as evaporates a unit of weight of water under the mean atmospheric pressure of 14·7 lbs. on the square inch, the water being supplied to the boiler at the same temperature at which it is evaporated; that is to say, at the *standard boiling point* of 212° Fahr., or 100° Cent. It is a perfectly definite unit of heat, and one that is easily measured and easily identified.

Then, in certain respects, it is identical in the measures of all countries whatsoever. There is no question about different standards of weight or measure, when we speak of the number of units of weight of water that are evaporated at the standard boiling point by a unit of weight of a given sort of fuel. That number is precisely the same whatsoever the system of measures we employ, whether British or French, or the system of any other nation.

The British unit of evaporation is this:—The quantity of heat that evaporates one pound avoirdupois of water at the standard boiling point of 212° Fahrenheit, or 100° Centigrade—the feed-water being supplied to the boiler at the same temperature at which it is evaporated. It is equal to 966 ordinary British units of heat: that is, 966 times the quantity of heat that raises the temperature of 1 lb. of water 1° Fahrenheit. The French unit of evaporation is the quantity of heat that evaporates one kilogramme of water at the same standard boiling point, and it is 537 ordinary French units of heat.*

Now, that is a unit of heat specially convenient for purposes connected with the practical employment of fuel. For one thing, it avoids the use of large numbers. That may seem, at first sight, a trifling matter; still, it is of considerable convenience in practical calculations, that we have to deal with units and tens, instead of thousands and tens of thousands. Another advantage is, that we have the heating powers of fuel expressed in terms of the practical effect that fuel is most frequently employed to produce. A third has been already referred to; viz., independence of special systems of weights and measures in expressing the heating powers of fuel.

Connected with the expression of quantities of heat in units of evaporation, is the experimental measurement of such quantities by means of the evaporation of water; and here, too, certain precautions must be observed in order to insure accuracy. In the first place, the condition that the water shall be "fed," or supplied to the boiler at the boiling-point, must either be exactly fulfilled, or any deviation from it must be ascertained and have its effect allowed for. In practice, the feed-water is almost always supplied at a lower temperature than the boiling point. Then the water is not evaporated under the standard atmospheric pressure; and a further correction is necessary, depending upon the difference between the actual boiling point and the standard or atmospheric boiling point.

With regard to the way in which the temperature of the feed-water and the temperature of the boiling point affect evaporation, I may refer to the following formula:—

$$\text{E (reduced)} = \text{E (observed)} \times \left\{1 + \frac{T_1 - T_f + 0{\cdot}3\ (T_b - T^1)}{966\text{ F. or }537\text{ C.}}\right\}$$

In the first place, you observe that the formula expresses this:—A certain weight of water has been actually evaporated, the feed water being supplied at some degrees lower than 212° Fahr., and possibly the boiling point being some degrees above 212°. I denote that weight by "E (observed)."

Now, in order to express this result in standard units of evaporation, we must reduce it to what the weight evaporated would have been had the feed water been supplied at 212° Fahr., and had the evaporation taken place at that same temperature; a weight denoted by "E reduced." For that purpose we must multiply the observed evaporation by 1 + a certain correction. And that correction is got at in this way. Let T_1 denote the boiling point, 212° Fahr. standard, and T_f the temperature of the feed-water. Then $T_1 - T_f$ is the number of degrees by which the temperature of the feed-water is below the standard boiling point. Let T_b stand for the actual boiling point; from that we subtract the standard boiling point T_1, and take three-tenths of the difference, viz., $0{\cdot}3\ (T_b - T_1)$. Upon this quantity depends the additional expenditure of heat, owing to the actual boiling point being above the standard boiling point. And having added together those two quantities, the depth of the temperature of the feed below the standard boiling point, and three-tenths of the height of the actual boiling point above the standard boiling point, we divide by 966 if the temperatures are taken on Fahrenheit's scale, or by 537 if on the Centigrade scale, and we get a certain quotient, generally a small fraction; we add that to unity, and we get a factor by which we multiply the observed evaporation, and the product is the "reduced evaporation."

If the actual boiling point has not been observed, it may still be calculated from the pressure; because there is a connection between the boiling point and the pressure, and the boiling point corresponding to a given pressure may be ascertained by means of formulæ or tables.

Besides this, great care must be taken that the true weight of water evaporated is ascertained. We must either take care that the boiler does not prime, or we must ascertain the amount of priming and allow for it. Priming is the carrying over of water in the liquid state, in the form of spray or mist, along with the steam. Supposing that in the apparatus used it is impossible to avoid priming, there is only one resource: that is, to use an apparatus which will stop all the liquid water from passing, and let nothing but the dry steam pass, and then condense the dry steam in a separate vessel and weigh it. That is scarcely practicable on a great scale, and in the rough sort of way in which many such experiments must be made; and therefore in such cases we must rely chiefly on taking care either that there is no priming, or, if that be impossible, that it is so small as to be unimportant.

Having explained the precise nature of the unit of heat which I intend to use, I will now speak in the first place of the *total* or *theoretical* evaporative power of a given sort of fuel, that is to say, the number of times its own weight of water that it would evaporate at the standard temperature, if there were absolutely no waste of heating power; and in the second place, of the *effective* or *available* evaporative power, being what we actually get with such furnaces and boilers as we have at our command.

I may observe that the ratio which the effective evaporative power bears to the total evaporative power is a fraction which we may call *the efficiency of the furnace and boiler*. For shortness, we will call it the *efficiency of the furnace*. If the whole of the heat employed by combustion could be effectively employed at the

* It is well known that a certain quantity of heat is equivalent to a certain quantity of mechanical work. For instance, we require to expend 772 foot-pounds of work in friction, in order to raise the temperature of 1 lb. of water 1° Fahr. If we multiply 772 by 966 we get the number of foot-pounds of mechanical work that we have to expend in friction, in order to evaporate 1 lb. of water: so that, to evaporate any given weight of water by mechanical work alone, we require to perform as much work as would lift the same weight up to the height expressed by the product; that is, 745,800 feet, or 227,300 metres, nearly. That is the dynamical equivalent of a unit of evaporation.

standard temperature, without any waste whatsoever, we should have an evaporative power represented, say by E. But the actual evaporative power is a smaller quantity, say E′: then we have the ratio,

$$\text{Efficiency of furnace} = \frac{\text{E′ (available)}}{\text{E (total)}},$$

which is a fraction less than unity; and the nearer that fraction approaches to unity, the more efficient the furnace and boiler are.

With respect to those two quantities—total evaporative power, and available evaporative power—it may further be remarked that the total evaporative power of a given sort of fuel depends upon its chemical composition alone; while available evaporative power depends not only upon the chemical composition of the fuel, but upon the construction and mode of management of the apparatus in which it is used, upon the supply of air, and upon a great variety of different circumstances.

With regard to the total evaporative power of different sorts of fuel as distinguished from the available evaporative power, we already possess very full and accurate information. Numerous careful experiments on that subject have been made in scientific laboratories; they have consisted in completely burning small quantities of different combustible substances, and measuring the heat with scientific apparatus of a very accurate kind, and taking special care that no heat escaped measurement. For example, in such experiments it has not always been practicable to prevent hot gases, the products of combustion, from passing away at an elevated temperature. But then the volume of those gases and their temperature could always be measured, and the heat that so passed away by the chimney calculated and allowed for. It is from experiments of that sort that our knowledge of the total or theoretical evaporative power of various combustible substances is derived. Many such experiments were made by Dulong, Despretz, and other chemists and natural philosophers, from which a great deal of valuable information was obtained; but the experiments now chiefly to be relied on are those of Messrs. Favre and Silbermann, published in the *Annales de Chimie et de Physique*, for 1852-53, volumes 34, 36, and 37. Those experiments have furnished us with a body of information which, as to combustible bodies that are of any practical importance, leaves nothing to be desired: that is, as to total or theoretical evaporative power. Our knowledge of available evaporative power is still imperfect: much has been learned, but much still remains to be learned.

I will now make some remarks specially upon the total or theoretical evaporative power of certain sorts of fuel as ascertained by the experiments to which I have referred.

We may distinguish the combustible substances to which those experiments relate into two classes—elementary substances and compound substances. I have stated the theoretical or total evaporative powers of the only elementary substances that are of any practical importance in this table:—

Element.	Oxygen per unit of weight.	Air per unit of weight.	Units of evaporation.	
(1) Hydrogen gas, . . .	8	36	64·2	
(2) Carbon, solid, . . .	$2\frac{2}{3}$	12	15·0	
(3) Carbon, solid, with half supply of oxygen, ...	$1\frac{1}{3}$	6	4·5	15·0
(4) Carbon, gaseous, in $2\frac{1}{3}$ parts of carbonic oxide, ...	$1\frac{1}{3}$	6	10·5	
(5) Carbon, pure gaseous (inferred by theory)	$2\frac{2}{3}$	12	21?	

You will observe that there are three columns of figures following the name of the elementary substance. The first expresses the weight of oxygen that is required in order to burn completely an unit of weight of that elementary substance. For example, 1 lb. of hydrogen requires 8 lbs. of oxygen for its complete combustion. In order to supply that oxygen there are 36 lbs. of air required; and in the second column of figures is stated the weight of air. The third column gives the total or theoretical evaporative power, which in the case of hydrogen is 64·2 times its own weight. It has the greatest evaporative power of all known substances. Then follows carbon. A pound of carbon requires $2\frac{2}{3}$ lbs. of oxygen to burn it completely, and to supply that oxygen 12 lbs. of air are wanted; and the complete combustion of carbon produces heat enough to evaporate 15 times its own weight of water.

I may here observe that carbon exists in various states of aggregation, such as charcoal, coke, plumbago, and diamond; that the experiments of Favre and Silbermann were made upon it in those different states, and that the total heat of combustion differs according to the state of aggregation. The more hard and dense the carbon is, the less is the heat we get by the combustion—the reason evidently being that a certain quantity of that heat is expended in overcoming the attraction of the particles of carbon for each other. For example, diamond does not evaporate so much as 15 times its weight of water, because of the heat required to overcome its own cohesion. That has a bearing upon some other phenomena to which I will presently refer. But the quantity I have here set down is the result obtained from carbon in the ordinary states of charcoal and coke.

The third line in the table refers to the result produced by carbon when burned with only half the full quantity of oxygen. It is known to chemists that carbon combines in two different proportions with oxygen. One part of carbon by weight combined with one part and one-third of oxygen produces carbonic oxide. Carbonic oxide is itself a combustible gas, and in burning it combines with just as much additional oxygen as it already contains, so as to form carbonic acid. If we have a furnace ill supplied with air, so that the carbon only gets half the quantity of oxygen that it needs in order to form carbonic acid, then we have carbonic oxide as the product. Each pound of carbon takes up $1\frac{1}{3}$ lb. of oxygen, and to supply that oxygen 6 lbs. of air are required. The total evaporative power is diminished not merely to one-half, but to a great deal less than one-half: it is only 4·5, or three-tenths of 15, the total evaporative power with a full supply of oxygen.

If we next take that carbonic oxide, the weight of which will be $2\frac{1}{3}$ lbs., namely, 1 of carbon, and $1\frac{1}{3}$ of oxygen, and burn it, it takes an additional $1\frac{1}{3}$ lb. of oxygen to burn it; and we get exactly the quantity of heat necessary to make up the deficiency, namely $10\frac{1}{2}$. The $4\frac{1}{2}$ units of evaporation during the first process and the $10\frac{1}{2}$ during the second, give 15 in all, making up the whole evaporative power of carbon with a full supply of oxygen.

A conclusion can be drawn from this, which I will now explain. It is to be observed that in both those stages of the combustion of carbon, we have the very same thing happening chemically; we have $1\frac{1}{3}$ lb. of oxygen combining with 1 lb. of carbon. But there is this difference in the two stages. In the first stage, where the carbonic oxide is produced from solid carbon, the solid carbon has to be converted from the solid state to a state of vapour or of gas. In the second stage, we have the carbon already in the state of gas. Hence it appears that the cause of difference between the $4\frac{1}{2}$ units of evaporation due to the first stage, and the $10\frac{1}{2}$ due to the second stage of the combustion, must be, that during the first stage, 6 units of evaporation disappear in transforming the carbon from the solid to the gaseous condition: in other words, the *latent heat of evaporation of carbon is six times that of water*. Thus we arrive at the conclusion, that the total evaporative power of pure gaseous carbon is 21, from which if we subtract 6, the latent heat of evaporation of carbon, there remains 15, the total evaporative power of solid carbon.

I have marked that conclusion as to the total evaporative power of gaseous carbon with a note of interrogation (?), because it is a theoretical inference which has not been directly verified by experiment, but only deduced by reasoning. Still it seems to me that there can be little doubt of its truth.

If we could get pure carbon from any natural source in the gaseous state, we should have 21 units of evaporation by burning it, because we should save the six units that are employed to transform the carbon from the solid to the gaseous state—that is, those six units would be available for the evaporation of water.

So far, then, with regard to the total or theoretical evaporative power of the elements of fuel.

Now, as to that of their compounds.

It was at one time supposed, from experiments relied upon at the time, that in order to calculate the total evaporative power of a given compound, we had only to take the separate elementary substances of which it consisted, calculate the separate evaporative powers due to those constituents, and add them together. But in the present state of knowledge we know that such a result as that is not quite accurate: that we require to subtract whatsoever heat may be necessary to separate the constituents of the compound fuel from each other. There are cases where apparently there is no sensible expenditure of heat for that purpose. But in almost every actual case that we meet with, it is evident that a certain quantity of heat disappears in overcoming the attraction of the constituents of a compound fuel for each other. So that having calculated from our data regarding elementary substances the theoretical evaporative power due to the combination of the elements of a compound fuel with oxygen, we must not stop there, but we must subtract whatsoever heat may have to be expended in order to overcome the affinity of those elementary substances in the compound fuel for each other before they can combine with oxygen.

Having premised that, I may call attention to some results of scientific experiment as to the total evaporative power of certain kinds of compound fuel.

The only compound fuels that are of any practical importance are the compounds of hydrogen and carbon. It appears from the experiments of Favre and Silbermann, to which I have referred, that in the case of marsh-gas, which is a compound of two equivalents of carbon with four of hydrogen, or by weight, three parts of carbon to one of hydrogen, we have the following results:—

Constituents.	Equivs.	Parts by weight.	Oxygen.	Air.	Evaporative power.	
C	2	$\frac{3}{4}$	2	9	11·25	calculated as if solid.
H	4	$\frac{1}{4}$	2	9	16·05	
C_2H		1	4	18	27·3	sum.
		Evaporative power by experiment,			24·3	
				Difference,	3·0	

Three-fourths of the weight of marsh-gas is carbon; one-fourth is hydrogen. Now if we calculate the evaporative power by taking the constituents separately, we get three-fourths of 15, or 11·25 for the carbon, if solid; one-fourth of 64·2, or 16·05, for the hydrogen; making together 27·3. But the total evaporative power is found by experiment to be 24·3; so there is a disappearance of three units of evaporation, over and above a quantity equal to that which would disappear in evaporating three-fourths of an unit of weight of carbon, viz., $6 \times \frac{3}{4} = 4\frac{1}{2}$. That is evidently due to some affinity between the carbon and the hydrogen, which has to be overcome in order to separate them from each other; and which requires, in order to overcome it, the expenditure of $4\frac{1}{2} + 3$ $7\frac{1}{2}$ units of evaporation.

Then, in the case of olefiant gas, one of the chief constituents of coal-gas, we have—

Constituents.	Equivs.	Parts by weight.	Oxygen.	Air.	Units of evaporation.	
C	4	$\frac{6}{7}$	2·29	10·30	12·9	calculated as if solid.
H	4	$\frac{1}{7}$	1·14	5·13	9·2	
C_4H_4		1	3·43	15 43	22·1	

Here, calculating the total evaporative power from the constituents as before, we find it 22·1; and that is exactly verified by experiment. Still that very fact is itself a proof of the disappearance of some heat in separating the carbon from the hydrogen; because it has to be recollected that in coal-gas the carbon is gaseous; and if we get no more heat from the carbon in coal-gas than we get from

solid carbon, it proves that as much heat disappears in separating carbon from hydrogen in coal-gas as is required to evaporate the same quantity of solid carbon.

That is a fact of much importance, and it simplifies considerably the calculation of the total evaporative power of various hydrocarbons; for the calculation for olefiant gas, which I have given by way of example, is not a solitary instance. By applying a similar method of calculation to the experiments upon various compounds of hydrogen and carbon, it would appear that the expenditure of heat in separating the carbon from the hydrogen is, at all events to a very close approximation, the same as that required to convert the carbon from the solid to the gaseous state. Hence we get for all practical purposes a good approximation to the evaporative power of any such compound except marsh-gas, by taking the evaporative power of each unit of carbon in the compound as 15, and of each unit of hydrogen as 64, and then adding the results together. That has been verified for an immense variety of compounds. It does not hold with mathematical precision, but it holds with a degree of precision that is enough for any practical purpose.

Now as to the effect of the presence of oxygen in fuel. It was established some time ago by the researches of Dr. Joule, to whom science is immensely indebted for many discoveries of a similar kind, that a certain and definite quantity of heat is produced by the union of two chemical elements, and that precisely the same quantity of heat disappears in the separating of those elements. He verified that in a great number of cases, and established it as an universal law of nature. It holds in many other processes besides chemical combinations and decompositions, whether we are speaking of heat or of any other form of physical energy, that whatsoever quantity of energy we obtain by a given process, if we exactly reverse that process we have to expend precisely the same quantity of energy again.

If 8 lbs of oxygen combine with 1 lb. of hydrogen, they produce heat enough to evaporate 64 lbs of water. If we decompose that water by any contrivance, whether by the use of a galvanic battery, by the superior affinity of carbon for oxygen, or by any other process, precisely the same quantity of heat disappears in overcoming the attraction of the hydrogen and oxygen for each other. Now if oxygen enters into the chemical composition of any fuel, we have this result: calculate how much hydrogen that oxygen requires in order to form water—that is to say, one-eighth part of the weight of oxygen; then the oxygen present in the fuel renders just that quantity of hydrogen unavailable for the production of heat, and takes away from the total evaporative power 64 times the weight of the hydrogen so rendered unavailable. That being known, we have the following rule in the shape of a formula:—

$$E = 15\,C + 64\,H - 8\,O.$$

This, then, is the rule for calculating the theoretical evaporative power of any sort of fuel whose combustible materials are carbon and hydrogen from its chemical analysis. Distinguish the constituents into carbon, hydrogen, oxygen, and refuse. The refuse does harm as being a useless weight, but it does not take away from the heating power of the constituent parts that remain. For every unit of carbon that remains in the compound, we have 15 units of evaporation; and for every unit of hydrogen, in the absence of oxygen chemically combined with it, 64 units of evaporation; and if there is oxygen in the compound fuel, we have to subtract eight times the weight of that oxygen, because the oxygen renders inoperative one-eighth of its weight of hydrogen; and one-eighth of 64 is 8. The remainder gives the total evaporative power of that fuel.

The next formula shows the amount of air necessary in order to supply oxygen for the complete combustion of a compound fuel. It consists of 12 units of weight of air for each unit of carbon, and 36 for each unit of hydrogen, deducting $4\frac{1}{2}$ for each unit of oxygen in the compound; or in symbols,

$$A = 12\,C + 36\,H - 4\tfrac{1}{2}\,O.$$

In an actual furnace it is seldom sufficient to supply just the quantity of air that contains the oxygen required for complete combustion. It is in general necessary to supply a surplus of air in order to dilute and sweep away the *burnt gas*, as we may call it, and to insure that every particle of fuel shall have air brought in contact with it. In furnaces with a draught produced by a chimney in the common way, the practical result is, that we have to double the quantity of air, or nearly so. But when we produce a draught by a blast pipe, by steam jets, by a fan, or by other means, which thoroughly mix the air with the gaseous fuel, we reduce the surplus air required very much. In some cases we need only half; in some cases we need no surplus at all. Hence the quantity of air actually supplied, ranges from once to twice the quantity necessary for the oxidation of the fuel.

Here follows a table of examples of the total evaporative powers of some kinds of fuel, as calculated from their chemical composition:—

	C.	H.	O.	A.	E.	Evap. due to C.	Evap. due to H.−$\frac{O}{8}$
Charcoal, . . .	·93	0	0	11·5	14·0	14·0	0
Coke, . . .	·88	0	0	10·6	13·2	13·2	0
$C_{18}H_{20}$, . . .	·84	·16	0	15·75	22·7	12·7	10·0
$C_{26}H_{28}$, . .	·85	·15	0	15·65	22·5	12·66	9·84
Coal, . . .	·87	·05	·04	12·1	15·9	13 05	2·85
" . . .	·85	·05	·06	11·7	15·5	12·75	2·75
" . . .	·75	·05	·05	10·6	14·1	11·25	2·85
Peat, dry, . .	·56	·06	·31	7·7	10·0	8·5	1·5
Wood, dry, .	·50	·05	·40	6·0	7·5	7·5	0

The first line refers to charcoal; the second to coke of average quality; the third and fourth lines give two examples of hydrocarbons, which comprise between them the chief ingredients of rock-oil. In the third, fourth, and fifth columns are stated the proportions of the chemical constituents, ranging, for the rock oils, between 84 per cent. of carbon to 16 of hydrogen, and 85 per cent. of carbon to 15 of hydrogen. The fifth column gives the net weights of air required for the oxidation of the fuel. In the sixth column the theoretical evaporative powers are set down: for rock-oils they are from 22·7 to 22·5, or, in round numbers, we may say $22\frac{1}{2}$. In two additional columns are some figures to show how much evaporation is due to carbon and how much to hydrogen. In rock-oils, those quantities are $12\frac{1}{2}$ due to the carbon, and 10 to the hydrogen, out of the $22\frac{1}{2}$ units of evaporation. Lines 5, 6, and 7 give a few examples of coal. These might be immensely multiplied; but I have given only three specimens. They differ from the kinds of fuel previously mentioned, in having some oxygen in them, which somewhat lessens the evaporative power. Here, too, the units of evaporation due to carbon and to hydrogen are distinguished; for example, line 6 shows $12\frac{3}{4}$ units of evaporation due to carbon, and $2\frac{3}{4}$ due to hydrogen. Then follow some results for peat and for wood, on which I need not enlarge.

It is to be observed that the examples given in this table, which are only a few selections out of much more voluminous data, are all taken from good specimens. In fact, it is impossible to found experiments upon bad specimens of fuel, because people do not send bad specimens of fuel to be experimented upon. But it may be taken as the result of practical experience that the evaporative power of bad specimens of fuel from a particular district is about two-thirds that of good. This applies particularly to coal. The difference is chiefly due to refuse or ash. But it does not apply to mineral oils, because they can hardly contain anything else but combustible matter. They do not contain ash; they do not contain earthy matter. The statement then, about qualities of fuel which have only two-thirds of the total evaporative power of those set down in the table, applies to coal and peat; but it does not apply to mineral oils.

(*To be continued.*)

MONTHLY NOTES.

The Fifteen-inch Armour Plate for Fortresses.—Not long since the Atlas Works was the scene of the production of the thickest and altogether the largest plate yet produced. It measured in the furnace, before rolling, more than 20 feet in length, 4 feet wide, and 21 inches thick, the whole weight being about 21 tons. The thickest plate hitherto produced was 12 inches; this has therefore now been exceeded by the addition of 3 inches. A few of the 12-inch plates are in use, but the manufacture of plates 15 inches in thickness was not contemplated until the ironclad fort system was determined upon. These forts are designed with a plating of 5-inch armour, backed with a layer of 5-inch horizontal, and another of 5-inch vertical bars. This system of construction is certainly inferior to the solid, inasmuch as 8 inches of built-up plates are not equal in power of resistance to $4\frac{1}{2}$ inches of solid. But the reason why such a system of construction was decided upon is accounted for by the fact that it was thought impossible to make plates having a total thickness of 15 inches. This, however, has now been accomplished. The process of manufacture of these plates at the Atlas Works is as follows:—The proportions of peculiar metallic ingredients are kept secret, but it is known that the best cold blast pig iron from different districts mixed in given proportions is used. These metals are first puddled in masses of from three to four hundred-weight each. They are then worked under the steam-hammer, after which they are heated and passed through the small rolls. Three or more plates thus produced are then re-heated, and passed through larger rolls. These slabs are then ready for forming the final armour-plate, the number used being governed by the thickness of plate required. In the present instance, one 6-inch and five 3-inch plates were used. In making these thick plates a difficulty is experienced in the welding process in securing a uniform heat throughout the mass, so that the centre shall be sufficiently heated without the upper layers being overheated. This difficulty is met at the Atlas Works by placing cubes of highly carbonized iron between each layer of plates, thus keeping them apart. The flame and heat thus circulate freely between them, and every plate attains the same degree of heat about the same time. Another object is served by this process, for as the cubes melt they restore a certain amount of carbon to the iron, of which it has been deprived by the previous processes. The plates gradually settle down, and the melted cubes form a cement between them, helping to perfect the weld. The monster plate thus prepared was drawn from the furnace and conveyed to the rolls, through which it was passed and repassed, the rolls being gradually brought closer to each other, until, at the end of a quarter of an hour, the perfect armour plate 15 inches thick was produced. During the rolling, quantities of sand were thrown upon the plate, which formed a coating of silica upon it; water was also thrown on after the sand, and the surface of the plate swept to free it from every particle of oxidation. This enormous plate was produced by the labour of nearly 200 men, and involved the consumption of about 250 tons of coal. Specimens are to be cut from it and forwarded to the War Office and the Admiralty, so that with this example before them the authorities will perhaps see the necessity of abandoning the present designs, and substituting solid iron plating for the built-up thicknesses now adopted. If, therefore, the result of testing proves satisfactory—and we cannot doubt that it will—there will be no excuse for their non-adoption in our future fortifications. We believe that as soon as the use of such plates is countenanced by the heads of departments, that the cost, weight for weight, will be under that of thinner armour plates; at least, judging from the proportion of cost on the large scale of other branches of iron manufacture, there is every reason to suppose so.—V. D.

University College, London, Winter Session.—Professor Fleeming Jenkin, C.E., F.R.S., proposes to deliver, in the evening a series of Lectures on Engineering Subjects. Each course will consist of ten lectures.

The lecturer proposes to explain the application of mechanics and other kindred sciences, to questions such as occur to engineers in practice; and, in the first course, treating of bridges, the following points will be explained in detail:—

SUPERSTRUCTURE.

1st. Girders—distribution of strains in beams, lattice girders, trussed beams, continuous girders, cantilevers; ultimate strength and deflection; load, stationary and passing, best proportions of parts, various forms of girders adopted in Europe and America. Strength of wrought iron, cast iron, steel, and wood; how to support roadway, dimensions and weights of actual examples, convenient formulæ for calculation, estimates, and cost.

2nd. Suspension Bridges—distribution of strains in the simple and trussed forms.

ultimate strength and deflection, load, stationary and passing, best proportions, effect of trussing, effect of passage of railway trains and other loads. Various forms adopted, manner of joining the several parts, support on piers, anchorage, strength of chains and wire ropes, limit to span.

Dimensions and weights of actual examples, convenient formulæ for calculation, estimates, and cost.

3rd. Arches—metal arches, cast iron and wrought iron, usual theory of distribution of strains and thrust on abutments. Modification required in practice. Effect of trussing spandrils and stiffening roadway.

Most effective trussing and best proportions, details of construction, roadway how supported, strength of material and allowance for imperfect theory.

Examples, formulæ, estimates, and cost.

Wooden Arches—application of the theory to wooden arches.

Stone and Brick Arches—Usual theory, how far trustworthy; practical examples and formulæ for dimensions; strength of brick, stone, and cement; skew arches; spandrils, backing, drainage, coping, centering; examples, with dimensions, estimates, and cost.

4th. Swing Bridges and Drawbridges.

FOUNDATIONS.

1st. *On Land*—Dimensions of piers for the several forms of bridge. Abutments for suspension, arched, and girder bridges. Practical rules and formulæ examples.

2nd. *Foundations in Water*—Special circumstances to be provided against; pressure of water, ice, scouring. Capabilities of various piles. Various practical methods of executing work under water.

ERECTION OF BRIDGES.

Setting out; supervisions; tests of strength; inspection and repairs.

Any further information required can be obtained at the Secretary's Office, University College, Gower Street, London.

THE COINS OF COMMERCIAL NATIONS.—At the middle of the garden around which the great iron building of the Champ de Mars has been erected there stands a circular pavilion, very well known to visitors from its being so frequently made a place of rendezvous amongst friends. In this pavilion are deposited a series of weights, measures, and coins, contributed by various nations; the object in view on the part of those who got the collection together being to show the differences which exist between nation and nation in regard to what is of great importance in their commercial intercourse. A committee of delegates from different countries has been sitting at Paris during the summer, with the view of framing a scheme for bringing into uniformity the coinage of the countries they represent. Their report is not yet ready, but it may be looked for shortly. Meantime we will take a cursory glance at the coins in use among the countries in question. *France, Belgium, Switzerland,* and *Italy* have adopted coins of the same value, though differing occasionally in name, and the money of these countries therefore circulates in all the others as freely as at home, an immense convenience, as all travellers know from experience. *Austria* has six silver coins, of which the type is the gulden or florin, the value of which is 2*s.* 1*d.* There are coins representing the 20th, 10th, and 4th of a gulden, besides pieces having the value of 1½ gulden and 3 gulden. There are three gold coins, the ducat, value 9*s.* 9*d.*; the half-crown, 14*s.* 4*d.*; and the crown, 28*s.* 8*d.* There is this additional inconvenience in Austria, that the gold pieces have no fixed legal value, the price of each being regulated by the supply and demand of the hour. *Denmark.*—Here the money of account is the skilling, a bronze coin worth about the 40th part of a shilling. There are eight silver coins, the chief of which are the mark, worth 16 skillings; the 2 mark-piece, the rigsbank-daler, worth about 1*s.* 2*d.*, and the half and double of that piece. The gold coins are the ducat, value 10*s.*; the Frederick's or Christian's d'Or, value 17*s.* 1*d.*; and the double Christian. *Sweden* has two silver coins, the riksdaler, which is worth about 1*s.* 2*d.*, and the 4 riksdaler-piece, worth 9*s.* 9*d.* *Prussia* has three pieces of silver money; the thaler, worth about 3*s.* 1*d.*, and pieces representing the 6th of a thaler, and 2 thalers. There are two gold coins, the crown and the half-crown, their values being respectively 28*s.* 8*d.* and 14*s.* 4*d.* *Russia* coins seven silver pieces, ranging from the value of a penny to that of 3*s.* 4½*d*, including the letchervertok, worth 25 kopecks, that is, 10*d.*; and the rouble, 100 kopecks, 3*s.* 4*d.*; and two gold pieces, the ducat, value 10*s.*, and the palou, 17*s.* 2½*d.* *Spain.*—Here the money of account is the real, of which the value is 2½*d.* and the fraction of a farthing. The coins are the peseta, 10½*d.*; its half; the escudo, 2*s.* 2¼*d.*; and the duro, or piastre, 4*s.* 4½*d.* There is only one gold coin, the doubloon, 21*s.* 1*d.* *Portugal* has several silver coins, some old and some new. The coin of account is an imaginary one, the rei, 1000 of which make the pataca, about 4*s.* 5½*d.*, and 4500 equal the British sovereign. There are also several gold coins. In Brazil the coins are of the same value as in Portugal. *The United States of America* calculate in cents and dollars, the dollar being worth about 4*s.* 5*d.*, and the cent being its hundredth part. Their gold coins are the eagle (value 43*s.* 10*d.* if gold were not a premium), half eagle, and quarter eagle. As to the *British* coinage it is sufficient to say that it corresponds with none of those above mentioned; and that we make calculation as difficult as possible by having a different divisor for each type of the series, the penny being divided by 4, the shilling by 12, and the sovereign by 20. We hope the day is not far off when nations will have the common sense at least to divide their coins decimally; but we fear that national prejudice will long prevent the adoption of a common money system.

EXTRACTION OF OIL BY BISULPHIDE OF CARBON.—The extraction of vegetable oils by means of the bisulphide of carbon has made considerable progress on the Continent during the last few years, and there are now German houses who advertise that they undertake the erection of the machinery required. Heyl's process seems to be the favourite one. By this process it is said that from 5 to 8 per cent. more oil can be obtained than by good hydraulic presses. The residue of the seed contains 1 per cent. more azote than ordinary oilcake, and it therefore forms a better manure. All kinds of oil-yielding seeds may be thus treated, and in the Prussian section of the Paris Exhibition may be seen a collection sent by Heyl & Co. of twenty-one different kinds of oil obtained by this method, with specimens of the residues.

PARIS EXHIBITION.—CLOSING OF THE EXHIBITION.—BRITISH DIVISION.—I. It has been officially announced in the *Moniteur* that the Exhibition, in all its parts, as originally determined, will be finally closed on Thursday, 31st October, 1867.

II. The whole work of repacking and clearance of goods from the Champ de Mars, must be done by the exhibitors or their agents, who are recommended to be in Paris on 31st October, in order to look to the safety of their articles immediately at the close. *During the unavoidable bustle and confusion of removal, such safety can only be insured by the personal attendance of the exhibitors or their agents, upon whom the whole responsibility will solely rest.*

III. Empty packing cases left in the Exhibition building after the time prescribed by the Imperial Commission, 30th November, will be liable to be confiscated.

IV. The offices of the British Commission at 71 Champs Elysées, Paris, will be closed for the transaction of business on the 9th November, and at the Champ de Mars after 1st December. No letters addressed to exhibitors should be sent to either place after those days. All communications for the Executive Commission should be sent, after 1st December, addressed to the Secretary, British Commission for the Paris Exhibition of 1867, South Kensington Museum, London, W.

Nota Bene.—V. The empty packing cases of exhibitors are in the charge of M. Moréno Henriqués, who it is understood will only bring them to the Champ de Mars upon receiving from the exhibitors written orders, as well as the payments for removal, housing, &c., according to the published tariff (see below). Exhibitors will thus see that the *speedy* despatch of their objects will depend, in the first instance, upon the completion of all their arrangements with M. Moréno Henriqués.

VI. M. Moréno Henriqués will give every assistance, at reasonable charges, in passing through the customs, goods either sold, or to be returned to England; and exhibitors are recommended to prepare *at once* separate lists of sales and articles to be returned, so that *the lists may be completed before the 26th October.*

VII. The following extracts from the circular No. 51 (21st December, 1866) are reprinted below for the information of exhibitors.

STOWAGE OF EMPTY PACKING CASES.

14. The Paris Chamber of Commerce, wishing to assist foreign exhibitors as much as possible, have permitted their customs traffic manager, M. Moréno Henriqués, 17 Rue de la Douane, Paris, to make, under their authority, the following proposal for the care of empty cases. M. Moréno Henriqués will have a staff in the building, and the Chamber of Commerce have secured a site in the neighbourhood of it.

15. Extract from the Tariff of the Traffic Manager, approved by the Chamber of Commerce of Paris, on the 18th October, 1866:—

Stowage of Empty Cases.

16 Closing, numbering, removing, and conveying the empties to the warehouse (including men's time), classing, stowing, and keeping of the empties with all their appendages, and insuring the same against fire during the Exhibition, and taking the empties back to the Exhibition, will be charged at the following rates:—

Per case of one cubic metre and under, ...	2 francs.
For every metre above, or part of a metre, . . .	50 centimes.

17. The following instructions for the guidance of British exhibitors have been communicated by commissioners of her Majesty's Customs.

18. The goods on leaving this country should be cleared at the port of shipment by means of the usual shipping bill, which it is desirable should be headed "Goods for Paris Exhibition, 1867," and when returned, if the value of the goods do not exceed £50 they may be entered as "British returned from the Paris Exhibition," and delivered by the officers at the port of re-importation on a declaration to that effect; if the value exceed £50 the goods may be cleared by Bill of Store in accordance with the 65th section of the Customs Consolidation Act, 1853, or on special application to the commissioners of Customs accompanied by a declaration of their being British goods.

If the goods be such as are entitled to drawback on exportation, such drawback will be required to be repaid on re-importation, or satisfactory proof adduced that it was not received on the goods leaving this country.

VIII. Exhibitors will determine for themselves by which routes their objects will be returned to England, and make their own arrangements accordingly.

(Signed) R. G. WYLDE,
Secretary to the Executive Commission.

71 Champs Elysées, Paris,
October, 1867.

Since the date of this notice it has, by special request of the Emperor, been determined to keep the Exhibition open until the 17th of November.

NEW METHOD OF CONVERTING STEEL.—The process invented by Mr. Heaton, of the Langley Mills, Nottingham, for purifying pig iron and converting it into a kind of steel, is thus sketched in the *Ironmonger*:—The mode of procedure is to place from seven to nine lbs. of nitrate of soda in a movable bottom, which, with a perforated iron plate over the salt, is clamped to a cylindrical converter lined with fire-bricks, and having an upright funnel to carry off the products of combustion. A charge of about fourteen cwt. is run into this converter from a cupola. Rapid combustion takes place for about two minutes and a half. At first ruddy fumes, arising from the decomposed nitrate, are given off. The flame then becomes bluish, and finally dark-coloured, after which a series of sharp explosions follow in rapid succession, and brilliant sparks are given off, something similar to the scintillations observable in the Bessemer process. When the action has subsided, the molten metal is run into ingots. It is said that a substance closely resembling steel has been made by this process, but the experiments do not seem to have been yet conducted with that systematic accuracy which is desirable before the results can be relied on unhesitatingly. The trade will await with interest the further experiments in progress, and also the publication of analyses showing the nature of the products obtained by this chemical process. Already several Staffordshire firms have taken up the matter, and are said to be satisfied of the value of the process. They intend to apply it specially to the purification of the cinder iron produced extensively there. The growing necessity for the production of steel in large quantities to serve many purposes hitherto fulfilled only by iron is

occasioning a call for a converting process, which does not entail the very heavy cost incident to the adoption of the Bessemer principle.

Lauth's New Machinery for Rolling Metal.—Between the two ordinary rolls in general use are smaller rolls, and the heated metal plate is passed through, and returned by the "underhand" without the necessity of lifting over the rolls, thus saving fatigue to the workman and facilitating the progress of the work. In fact, so rapid is the action that two good workmen may, with less fatigue than is occasioned by the old system, produce in one day three times the amount of finished work that can be accomplished by the old system. Another striking advantage is that less friction is caused in the working than in the two-roll machines, the rolls in the improved machine acting as self-polishers, thus doing away with the necessity of turning the rolls weekly, as is necessary with the two-roll machines. It is claimed for the patented system that the plates produced present an equality of surface not to be obtained by the ordinary method, which is, of course, a valuable addition to the merits of the invention. Whilst the rolls are in operation a jet of water is thrown on from a perforated pipe, running the entire length of the rolls; and this has the effect of keeping them from becoming heated, and makes the operations of the workmen less fatiguing. The Darlaston Steel and Iron Company are so satisfied with the utility of the invention that they have ordered from the patentee two more sets for the purpose of rolling hoops. The machine they at present have in operation is the No. 14-inch gauge, and the plates rolled are 38 inches wide, and about 9 feet long. Although new in England, the patent has been for some time at work in the United States.—*Ironmonger.*

Henckel & Seck's Patent Apparatus for Hulling and Winnowing Grain.—The object of this improved patent apparatus for hulling and winnowing grain, invented by Messrs. Henckel & Seck, Frankfort, is to separate from the kernels of wheat and other grain the hulls which remain after the chaff has been removed by the operation of threshing and winnowing. Corn or wheat consists, besides its hulls, &c., of about 94 per cent. of flour, suitable for baking bread, of which, however, scarcely 80 per cent. can be secured by the system of producing at present in use. No better result has been as yet obtained, because we grind our wheat or other grains without previously removing the hulls, and endeavour then to separate the bran from the flour, by using Bolt cloths or otherwise. Though corn mills of modern construction are generally fitted up with the very best kinds of machinery, especially with respect to Bolters, it will nevertheless be obvious that a considerable quantity of valuable flour must remain amongst the bran, and thus become wasted or only fit for inferior purposes. This unsatisfactory result in a branch of industry so eminently important to the welfare of the world has already for some time occupied the minds of scientific men of all nations, without a result being obtained in any way similar to or nearly so satisfactory as obtained by employing the apparatus recently invented by Messrs. Henckel & Seck. After a great many other machines have been constructed, and afterwards relinquished by the public, as being far from perfect, and after all chemical means have been tried for the same purpose, Messrs. Henckel & Seck are stated to have solved the problem. Two nominal horse-power is quite sufficient to drive the apparatus at an average speed of about 160 revolutions per minute, delivering during one hour's work from 8 to 10 cwt. of peeled corn, that is, producing an article which, in the first instance, is perfectly free from corn mite, or any particle of dust or dirt. The following advantages are stated by those interested to be secured by the apparatus:—Peeled wheat will yield flour of superior quality, as a rule being finer, whiter, and of more delicate flavour; the quantity of flour obtained is greater than that obtained in the ordinary way, while a larger proportion consists of the better numbers; the quality of each number of flour is materially improved by this process, and therefore a superior quality of bread or biscuit is obtained; the grinding process in itself becomes easier, as no impurities can interfere with it or become injurious to the stones, and thus the ordinary capabilities of a mill are increased; there is a reduction of labour, and the millstones last longer. The bran produced by this apparatus is an excellent raw material for manufacturing paper, and will fetch good prices. Space required, $5\frac{1}{4}$ feet of ground to 7 feet in height; minimum size of bran chambers, $3\frac{1}{4}$ feet $\times$ $6\frac{1}{2}$ feet $\times$ $6\frac{1}{2}$ feet. Horizontal shaft, with pulley wheel of about 20 inches diameter. Mr. Frederick Seebohm, London, is agent for the United Kingdom and the colonies.

The Manufactures of Dundee.—The first spinning mill in the town was erected in 1792. At the end of the last century five mills, of the aggregate of 60 horse-power, and containing about 2000 spindles, were in operation. But in 1811 the number of mills was reduced to two. In 1820 the trade began to revive, and in 1832 the number had increased to forty-three mills, with an aggregate of 724 horse-power. Up to this period flax and hemp were the raw materials chiefly used. About 1833 jute began to be introduced, and this article has completely changed the character of the trade, for the jute manufacture is now the great staple of Dundee. In 1851, 1947 horse-power were employed in Dundee. The Crimean war gave a great impulse to the trade of the district, and during the late American war so vast were the requirements of the belligerents on both sides that many new mills and factories were built, and old ones extended. The scarcity and consequent high price of cotton still further increased the consumption of linens, and this also stimulated the erection of new mills and factories. In 1864 there were sixty-one firms engaged in spinning and weaving by power in Dundee, having 160 steam-engines of 4621 horse-power, driving 170,552 spindles, and 6709 power-looms, and employing 36,020 persons. At the present time seventy-two firms own spinning-mills or power-loom factories, or both, of 5822 horse-power, containing 202,466 spindles, and 7992 power-looms. In these works 35,310 persons are employed, and the same firms also employ 6240 persons in handloom weaving, and in other departments, making a total of 41,550 persons employed by them. In addition to these firms there are many manufacturers who have no power-looms, but the number of hand-loom weavers, winders, &c., employed by them has not been correctly ascertained. There are also many persons engaged in the public calenders and in other auxiliary branches of the trade. The total number of persons directly engaged in the various branches of the linen manufacture in Dundee cannot be much, if at all, short of 60,000. The buildings which have been erected in Dundee for spinning and weaving are imposing structures, internally furnished with every modern appliance to render them salubrious and healthy. As the different floors are lofty and the whole thoroughly ventilated, the workers enjoy a degree of comfort unknown to their predecessors. The machinery in the various mills and factories is as well adapted for the work it has to perform as human ingenuity can make it, and it is invariably kept in the most complete order. This year the consumption of jute will be about 65,000 tons. Including hemp, the consumption of material in Dundee is at present at the rate of about 90,000 tons a year, and the cost of this material is about two and a half million pounds sterling. In the district of which Dundee is the centre, but excluding Dundee, the average annual consumption of flax and tow for the ten years prior to 1862 was about 25,000 tons. It is at present about 37,000 tons of flax and tow, 2000 of hemp, and 1000 tons of jute, being in all 40,000 tons, the cost of which is about one and three-quarter million pounds sterling. In the entire district, including Dundee, there are now, therefore, about 130,000 tons of flax, hemp, and jute consumed annually, the cost of which is about four and a quarter million pounds sterling. In the district, excluding Dundee, the details of which have already been given, there are 110 firms in the linen trade, employing steam or water power of the aggregate of 6290 horse-power, driving 191,452 spindles and 10,151 power-looms, and employing 28,875 persons. The only way of approximating to the quantity of yarn spun is by multiplying the spindles by the average daily spin of each. This gives a total of about 31,000,000 spindles for Dundee, and 29,000,000 for the district, making together 60,000,000 spindles of yarn spun annually, which at the average price of 2s. 3d. per spindle gives a value of £6,750,000. It is estimated that the total value of the yarn and linen made in Dundee and throughout the district cannot be under £8,000,000. The capital invested in the spinning-mills and power-loom factories in Dundee is about £2,500,000., and those in the district £2,200,000.—together, £4,700,000. When the works now in course of erection are completed, which will be within a few months, they will bring up the total cost of the whole to £5,000,000. The amount invested in bleachworks, calenders, and other auxiliary branches of the trade cannot be less than £1,000,000. If to these sums be added the average value of the stock-in-trade in the hands of the spinners, manufacturers, and merchants, it will be within the mark to estimate the capital required to carry on the trade of Dundee and the district around at £10,000,000.—*Mr. A. J. Warden; British Association.*

An American Gas Cooking Stove.—Solomon declared there was nothing new under the sun. We declare that there is something new under the sun, and that it is a gas cooking and heating stove. A gas stove is not only an utilitarian invention, but an aid to morality. It will raise the temperature in our rooms and check profanity; furnish us with a delightful atmosphere and insure the serenity of our spouses. It will save our pockets from depletion: protect us from the rigours of keen winters' blasts; render late dinners obsolete or mere matters of choice; banish ill temper and make the fortunes of the inventors. The Cambridge Gas Stove and Boiler Company is not composed of philanthropists but of strong-sensed practical business men. They propose to do the world a benefit, and divide the profits with it. What man does not wish them unlimited success so long as he shares with them? If there is a housekeeper, restaurateur, or hotel proprietor in the city who does not examine the gas stove, he has not injured the company, but himself. Let him go on in his ignorance and pay for it. Let him with difficulty make both ends meet; and perish finally without a dollar for his relations to quarrel over. When he is twenty years dust, inexorable fate will erect a gas stove over his lodging place, and cook a dinner for forty persons at the cost of one cent. The gas stove, either for heating or cooking purposes, is very much like any stove, except in the matter of consumption and trouble. The fire can be started as quickly as one would explode a pistol. The room can be heated in less time than the servant can bring up a bucket of coal. A meal may be cooked in fifteen minutes, and all at a cost of from one or two to ten cents. We have to lay in no burdensome stock of fuel. It makes no difference to us whether miners strike or work; we are secure from cold or political discontent—from the monopoly of labour organizations or the tyranny of servants.—*American Newspaper.*

South Lancashire Coal.—The South Lancashire and Cheshire Coal Association have for some time past been carrying on an elaborate series of experiments, the object being to test the economic efficiency of the coals of the district, and to ascertain the most economical form of boiler, the best mode of firing, whether mechanically or by hand, so as to evaporate the greatest amount of water with a given quantity of coal without the production of smoke. The experiments, which are not yet completed, have been conducted on a large scale, under the joint superintendence of Dr. Richardson, of Newcastle, and Mr. Fletcher, chief engineer of the Association for Preventing Steam Boiler Explosions. The trials have clearly shown that the formation of smoke may be entirely prevented, without any diminution of the evaporative efficiency of the coal, by careful firing alone; while it has been found that the coals raised in this district will realize as high an economy and efficiency as the best north country and Welsh coals, and that without the production of smoke.

Wire-cutter.—A cheap and efficient wire-cutter may be made of a plate of steel, fastened perpendicularly to the bench by an extension of the lower part of the plate, a nut holding it firmly in place. The upper part of the bar has a number of holes drilled to receive the wire to be cut, and at the extreme upper portion there is a hole to receive the bolt that forms the pivot upon which the cutting blade is hung. The end where the holes are made must be nicely tempered. It will be observed that the cutting blade is made of a T-shape, and hung upon the pivot bolt in such a manner that when the handle is lowered the cutting edge of the pivoted end severs the wire, if thrust through any one of the holes in the plate. A gauge to determine the length of the wire can be fixed by means of a screw in the lower portion of the plate. By making the cutter-blades of a T-form, if one blade should become broken or injured the opposite blade can be used, and no time will be lost at that particular moment in stopping to repair the injured blade.—*American Artizan.*

APPLICATIONS FOR

PROVISIONAL PROTECTION FOR INVENTIONS

UNDER THE PATENT LAW AMENDMENT ACT.

☞ When the city or town is not mentioned, London is to be understood.

9th September, 1867.

2543 C. Burn, Westminster—Propelling railway or other carriages
2544 E. J. C. Welch, Harrow—Producing artificial ice
2545 A. Paul, Dumbarton—Stoppers for ships' cables
2546 W. E. Gedge, Strand—Textile fabrics.—A com.
2547 W. R. Lake, Chancery Lane—Cartridge holder.—A com.
2548 C. E. Brooman, Fleet Street—Producing hydrogen.—A com.
2549 F. Tolhausen, Paris—Disinfecting fecal matters.—A com.
2550 G. Clark, Strand—Cartridges
2551 D. C. Brown, Massachusetts—Wire heddles
2552 J. Marsden, Halifax—Weaving Scotch carpets
2553 J. Eichharn, Westminster—Melting iron
2554 J. Turnock, Ross—Cask stands
2555 J. Medhurst, Bermondsey—Fitting ships' rudders

10th September, 1867.

2556 J. Jordan, Liverpool—Stuffing boxes
2557 C. J. Spencer, Queen Street Place, and F. Ware, Stratford—Steam boilers
2558 J. Dicken, Llanddulas—Railway fish plates
2559 J. H. Brown, Romsey—Compressed leather
2560 J. Holliday, Falcon Square—Fringes
2561 C. E. Brooman, Fleet Street—Thermometers.—A com.
2562 J. Eichharn, Westminster—Steam boiler.—A com
2563 C. Sutton, Holloway Road—Optical apparatus
2564 J. Rae, Lower Sydenham—Cleansing water
2565 J. Whittome, Walworth—Baling presses
2566 A. Kinton, Road—Water wheels
2567 J. Pottle, Little Bealings—Cucumber box

11th September, 1867.

2568 C. Mather, Manchester—Washing ores
2569 E. K. Dutton, and Samuel Mason, Manchester—Bearings of hydro-extractors
2570 S. Brown, Blackfriars' Road—Ornamenting bottles
2571 W. Baker, Tipton—Manufacture of iron
2572 A. M. Clark, Chancery Lane—Polishing marble.—A com.
2573 W. Baird, Glasgow—Registering the number of passengers entering vehicles
2574 F. Weintraude, Aldermanbury—Purses.—A com.
2575 J. Davies, Bowdon—Manufacture of salt
2576 L. M. Prewitt, Bristol—Stays
2577 H. R. Lockes, Coleford—Artificial fuel
2578 W. E. Newton, Chancery Lane—Anvils.—A com.
2579 W. E. Newton, Chancery Lane—Saws.—A com.
2580 W. F. Cooke, Aberia—Quarrying slate

12th September, 1867.

2581 J. B. Meldrum, New Jersey—Textile fabrics
2582 H. Stewart, Liverpool—Reaping machines
2583 J. Wilderspin, Elsworth—Horse rakes
2584 J. Perrin, Hyde—Fuel economizer
2585 J. W. Halfpenny, Aldersgate Street—Tobacco pipes
2586 C. Oates, Stourbridge—Ladders
2587 J. R. Cooper, Birmingham—Fire-arms
2588 W. Brown, Smethwick—Rolling hoops

13th September, 1867.

2589 H. Symons, Dulwich—Fire-screens
2590 P. R. Couchoud, Paris—Manufacturing of chenille
2591 J. Reid, Glasgow—Locomotive wheels
2592 F. A. Paget, Adelphi—Preventing the deviation of compasses
2593 W. F. Batho, Birmingham—Heating and cooling liquids
2594 R. Lowe and J. Taylor, Birmingham—Jewellery
2595 J. M. Napier, Lambeth—Stands for wine glasses
2596 S. Dalton, Chester—Iron and steel
2597 W. Whitehead, Dartford—Printing fabrics

14th September, 1867.

2598 H. A. Bonneville, Paris—Railway brake.—A com.
2599 W. G. Brownson, Wellsville—Telegraphic repeaters
2600 W. E. Newton, Chancery Lane—Increasing the efficiency of steam.—A com.
2601 J. Antill, Wandsworth, G. Grimes, Lambeth, and H. C. Tunks, Chelsea—Cores used in casting metallic pipes
2602 H. A. Bordin, Paris—Preventing sea sickness
2603 R. Canham, Clerkenwell—Sharpening knives
2604 J. Jeyes, Stanley Road—Substitute for oiled silk

16th September, 1867

2605 P. Crause, Dorset Square—Propelling boats
2606 G. Pickin, Birmingham—Treatment of mineral oils.—A com.
2607 J. A. M'Kean, Paris—Cutting rocks —A com.
2608 P. Dumont, Coronation Place—Manufacture of soap.—A com.
2609 G. F. Bradbury, Oldham—Sewing machines
2610 W. J. Cunningham, New Oxford Street—Sewing machines

17th September, 1867.

2611 C. Holste, Covent Garden—Blast furnaces.—A com.
2612 W. L. Duc, St. Heliers—Covering roofs
2613 W. Brailsford and J. Gadsby, Nottingham—Manufacture of lace on bobbin-net machines
2614 J. C. Bayley and D. Campbell, Adelphi—Fire-lighters
2615 T. Turner, Bristol—Mounts for maps
2616 S. Jay, Kentish Town—Adjusting scarfs
2617 S. C. Amesbury, Brighton—Communication on railways
2618 T. Bell, Hampstead—Extracting sulphur from oxide of iron residues
2619 D. Gardner, Glasgow—Spring mattresses
2620 T. Stevenson, City Road—Fire-lighters
2621 A. M. Clark, Chancery Lane—Valve closet apparatus.—A com.

18th September, 1867.

2622 F. H. Varley, Kentish Town Road—Testing telegraph conductors
2623 W. W. Burdon, Newcastle—Bleaching fibres
2624 C. Litster and G. Storey, Manchester—Looms for weaving
2625 T. Adams and G. J. Parson, Adelphi—Slide valves
2626 J. Soames, Greenwich—Candle fixer
2627 T. B. Wilkinson, Ipswich—Crushing grain
2628 H. M. Mellor, Nottingham—Knitting frames

19th September, 1867.

2629 R. Watson, Liverpool—Distributing gas
2630 T. C. Clarkson, Blackfriars' Road—Ammunition boxes
2631 P. Porter, Fleet Street—Blind rollers
2632 J. Rust, Lambeth—Materials for decoration
2633 W. J. Murphy, Cork—Motive power
2634 J. Higgins, Norwich—Polarizing kaleidoscope
2635 W. Molineaux, Wolverhampton—Rolling iron
2636 T. Bletcher, Chancery Lane—Sewing machines
2637 J. G. Willans, Bayswater—Manufacturing iron
2638 H. Fisher, Birkenhead—Steam-boiler furnaces
2639 J. H. Sams, Aberdeen—Agricultural implements

20th September, 1867.

2640 W. W. Gibson, Edinburgh—Decorticating and cleaning cereals
2641 W. Potts, Handsworth—Ventilating buildings
2642 J. J. Harrison and E. Harrison, Lower Broughton—Carding engines
2643 L. Lenzberg, Oxford Street—Gas lamps
2644 A. M. Clark, Chancery Lane—Colouring artificial flowers.—A com.
2645 F. T. M. A. Guyon, Saint Brieux—A typographic fixiform
2646 C. M'Dermott, Brixton—Slate sponge
2647 C. M'Dermott, Brixton—Metallic seal for envelopes.—A com.
2648 J. G. Tongue, Chancery Lane—Preparation of oils.—A com.
2649 R. Raffault, Paris—Petticoat
2650 S. Dreyfous, Paris—Bread ovens.—A com.
2651 E. H. Newby, King William Street—Alarm apparatus
2652 W. Hall, Salford—Separating yeast from liquid matters
2653 W. E. Newton, Chancery Lane—Whips.—A com.

21st September, 1867.

2654 C. E. Green, Portman Square, and J. Green, Edmonton—Cartridge for breech-loading fire-arms
2655 P. Crause, Dorset Square—Ventilators for hats
2656 G. E. Marchiso, Portman Square—Preparing anti-corrosive compositions
2657 J. Hargreaves, Appleton—Manufacture of iron
2658 D. Howard, Dobcross—Flannels
2659 J. S. Williamson, Long Hill—Drying and cleaning grain
2660 A. L. Dickins, and H. Heywood, Middleton—Printing yarns
2661 D. T. Lee, Birmingham—Preparation of food
2662 B. and A. B. Blackburn, Chelsea—Lucifer matches
2663 J. Meiklejohn, Dalkeith—Hoisting apparatus
2664 J. Baird, Croy—Treatment of jute
2665 A. M'Kenzie and S. Robinson, Dublin—Preventing waste of water
2666 D. Spill, South Hackney—Treatment of xyloidine
2667 T. Muir, Glasgow—Washing printers' rollers
2668 A. Atchison, Peckham, and H. J. Grantham, Bermondsey—Production of carburetted gas
2669 J. Rives, Paris—Metallic pens
2670 S. C. Lister, Manningham—Furnaces
2671 T. Kendrick, Wednesbury—Self-acting folding carriage steps
2672 J. R. Cooper, Birmingham—Fire-arms

23rd September, 1867.

2673 G. W. M'George, Pimlico—Pipes for smoking
2674 C. Ritchie, Brixton—Regulating the supply of water to steam boilers
2675 J. Griffin, St. Ann's Road, and F. Green, Watling Street—Manufacture of envelopes
2676 J. Fletcher, Salford—Steam hammers
2677 W. Cooke, St. James'—Regulating currents of air
2678 J. Hargreaves, Appleton—Separating pyrites from coal
2679 W. Beardmore, W. Brock, and A. C. Kirk, Glasgow—Furnaces
2680 J. Blair, Glasgow—Revivifying animal charcoal
2681 R. Wappenstein and A. Laidlaw, St. Mary Axe—Envelopes
2682 L. R. Bodmer, Notting Hill—Constructing air cylinders of blast engines
2683 A. M. Clark, Chancery Lane—Boots and shoes.—A com.
2684 S. Bevan, Pentonville—Ventilating underground railways
2685 A. Ziegele, Mincing Lane—Manufacture of epsom salts.—A com.

24th September, 1867.

2686 H. Forbes, St. Pancras—Rotary pumps
2687 W. Winter, Leeds—Sewing machines
2688 G. Batchelor, Liverpool—Trough water closets
2689 J. Lewis, W. Huntington, and W. Anyon, jun., Preston—Movable fire-bars
2690 J. H. Brown, Romsey—Manufacture of paper
2691 P. H. Colomb, Harrow, and F. J. Bolton, Rochester—Producing light for signalling
2692 T. H. Williams, St. Martin's Lane—Gas burners

25th September, 1867.

2693 R. Wilson and J. Nuttall, Patricroft—Heavy forgings
2694 C. D. Abel, Chancery Lane—Manufacture of gas.—A com.
2695 J. C. Bayley and D. Campbell, Adelphi—Projectiles
2696 D. R. Ratcliff, Liverpool—Manufacture of safes
2697 W. M'J. Cranston, Upper Thames Street—Implements for digging potatoes.—A com.
2698 J. Musgrave, Belfast—Fittings for stables
2699 A. Tod, Glasgow, and J. Heatley, jun., Alnwick—Manufacture of tobacco
2700 G. Clayton and W. Marbeck, Leeds—Water meters
2701 W. Woodcock, Pimlico—Ventilating buildings
2702 R. Waygood, Southwark—Cleaning rice
2703 A. Rooker, East Street—Taps for beer casks
2704 J. Bower, Hunslet—Manufacture of iron and steel
2705 A. M. Clark, Chancery Lane—Self guide or baster.—A com.
2706 J. J. Kirk, jun., Lenton—Lace

26th September, 1867.

2707 J. Oxley, Frome—Refrigerators for cooling worts
2708 G. H. J. Simmons, Hampstead Road—Lamps
2709 J. A. Smyth, Kingstown—Cinder sifters
2710 A. Taylor, Paisley—Weaving ornamental fabrics
2711 R. W. Bennie, Glasgow—Moulder's blacking
2712 J. Syme, Fore Street—Supporting window sashes
2713 J. B. and R. Wood, Sowerby Bridge—Steam engines
2714 A. Morrall, Studley—Manufacture of fish hooks
2715 J. Jameson Gateshead—Manufacture of paper
2716 G. Wilkinson, Bromley—Pumps
2717 E. T. Horsley, Alfreton, and C. Horsley, City Road—Producing a glazed surface on cast iron
2718 J. Brunton, Notting Hill—Raising water.—A com.
2719 J. Jameson, Gateshead—Indicating value of cheques
2720 A. V. Newton, Chancery Lane—Screw cutting.—A com.
2721 J. Fordred, Blackheath—Purifying paraffin
2722 J. H. Johnson, Lincoln's Inn Fields—Supplying steam boilers with water.—A com.
2723 T. and O. Vaughton, Birmingham—Neck-tie ribbon

27th September, 1867.

2724 J. E. H. Andrew, Pendleton—Looms for weaving
2725 R. Adams, Forest Hill—Extracting cartridge cases
2726 M. Samuelson, Hull—Sewing machines
2727 F. Frew and J. Speirs, Glasgow—Looms for weaving

2728 A. M. Clark, Chancery Lane—Hat-blocking machines.—A com.
2729 S. Parr and A. Strong, Cannon Street—Construction of buildings
2730 J. and F. S. Cocker, Islington—Transmitting signals
2731 L. De La Peyrouse, Portman Square—Treating of paraffin
2732 F. Branscombe, Brewer Street—Drilling and cutting
2733 J. and S. A. Huggett, Eastbourne—Horse nails
2734 F. Meyer and W. Wainwright, Lambeth—Manufacture of candles

28th September, 1867.

2735 C. Mole, Farringdon Road—Preparing soles and heels for boots and shoes
2736 H. A. Bonneville, Paris—Treating skins.—A com.
2737 L. Laine, Paris—Fan
2738 A. Ward and C. G. Virgo, Bradford—Wearing apparel
2739 J. H. Johnson, Lincoln's Inn Fields—Railway wheels.—A com.
2740 G. R. Solomon, jun., Liverpool—Registering passengers travelling in public vehicles
2741 E. Lever, Gorton—Lamps
2742 A. Killogg, New Haven—Manufacture of hats
2743 J. Elder, Glasgow—Propelling floating batteries
2744 M. Hamer, Manchester—India-rubber tubing
2745 T. Prideaux, Sheffield—Blast furnaces
2746 T. Silver, Chancery Lane—Lubricating packing

30th September, 1867.

2747 B. Dobson and R. Halliwell, Bolton—Spinning
2748 C. P. Jones, Peckham—Cleaning ships' bottoms
2749 T. Weston, Birmingham—Metallic tubes
2750 J. Dimock, Cheapside—Boiling eggs
2751 W. J. and W. Hill, Birmingham—Securing watch chains
2752 J. Donald, Glasgow—Burning oil in furnaces
2753 J. Dewar, Kirkcaldy—Preserving potatoes
2754 C. Honegger, Rüti—Loom for weaving figured fabrics
2755 J. Clark, Paddington—Locomotive engines

1st October, 1867.

2756 E. P. Alexander, Lincoln's Inn Fields—Cast steel.—A com.
2757 T. Bird, Liverpool—Furnaces
2758 H. A. Bonneville, Paris—Spinning wool.—A com.
2759 J. G. Jones, Newport—Winding ropes
2760 G. Allibon, Worcester, and A. Maubre, Baker Street—Conversion of cereal into saccharine matters
2761 J. L. Field, Kensington—Candles
2762 G. F. Green, Leeds—Combined billiard and dining table
2763 W. Mitchell, Manchester—Sharpening knives
2764 W. E. Gedge, Strand—Match boxes.—A com.
2765 R. Fletcher, Derby—Caster
2766 T. F. Clarke, Apsley Cross—Bedsteads and mattresses

2nd October, 1867.

2767 W. and S. Smith, Keighley—Spinning machinery
2768 R. H. Taunton, Birmingham—Strip or sheet iron
2769 F. Parkes, Birmingham—Nails
2770 A. C. Henderson, Charing Cross—Sewing machines.—A com.
2771 C. J. Appleby, Southwark—Railway fastenings
2772 C. Ritchie, Brixton—Steam boilers
2773 J. H. Nelson and T. Briggs, Wakefield—Heating the feed-water of steam boilers
2774 M. Wright, Bradford—An improved species of fabric
2775 G. Ramsden, Dewsbury, L. Webster, Batleycarr, and J. Walker, Heckmonwike—Fulling machines
2776 F. J. Jeffrey, Liverpool—Urinals
2777 C. Mace, Sunderland—Marine steam boilers
2778 H. Haschke, Watling Street—Breech-loading fire-arms.—A com.
2779 W. R. Lake, Chancery Lane—Sewing boots and shoes.—A com.

3rd October, 1867.

2780 W. Spence, Chancery Lane—Ovens.—A com.
2781 R. Dick, Motherwell—Heating blast for smelting and other furnaces
2782 H. D. Pochin, Salford, and E. Hunt, Manchester—Furnaces
2783 G. P. Dodge, Upper Thames Street—India-rubber mats
2784 W. E. Gedge, Strand—Portable laboratory
2785 A. M. Clark, Chancery Lane—Treatment of cotton.—A com.
2786 E. B. De Richebourg, Paris—Mode of advertising
2787 G. Townsend, Redditch—Machine needles
2788 G. Mellor, York—Nails and spikes
2789 A. T. Becks, Birmingham—Utilization of Bessemer steel scrap

4th October, 1867.

2790 T. Sagar and T. Richmond, Burnley—Looms for weaving
2791 S. Johnson, Crook—Moulding bricks and other articles
2792 H. Pinkus, Haverstock Park—Constructing steam generators for engines
2793 A. Ford, Arthur Street West—Apparatus for assisting swimming
2794 J. Gutmann, Berlin—Sewing machines
2795 W. Smith, Manchester—Point indicators used on railways
2796 J. Offord, Oxford Street—Railway and other carriages
2797 R. Ellis, Kingstown—Disconnecting conveyances from animals drawing them
2798 G. H. D. Mathias, East Cowes—Ships and vessels
2799 J. H. Johnson, Lincoln's Inn Fields—Manufacture of bread.—A com.
2800 R. Hattersley, Manchester—Distributing printers' type

5th October, 1867.

2801 J. Anderson, Londonderry—Obtaining chlorine
2802 W. E. Gedge, Strand—Wrapper or bale cloth
2803 G. Martin, Toadsmoor—Treatment of mixed fabrics
2804 J. S Williamson, West Hartlepool—Drying corn
2805 W. Low and J. Treadwell, The Borough—Rivetting the soles of boats and shoes
2806 A. M. Gillham, Woolwich—Steam engines
2807 A. Bradburn and S. T. Marsh, Birmingham—Jointed rules
2808 W. R. Lake, Chancery Lane—Making bolts.—A com.
2809 L. Williams, Fenchurch Street—Combined lift and force pump.—A com.
2810 J. Piddington, Gracechurch Street—Pneumatic springs.—A com.
2811 N. F. Taylor, Stratford—Impregnating air and aeriform fluids

7th October, 1867.

2812 J. Goodfellow, Blackburn—Steam engines
2813 J. Smith, Keighley—Moulding metal
2814 H. Faulder, Stockport—Washing and cleaning fruit
2815 C. J. Galloway, Manchester—Looms for weaving
2816 C. D. Abel, Chancery Lane—Refining camphor
2817 R. P. Faucheux, Paris—Pipes and cigar tubes
2818 J. A. Mays, Finsbury Circus—Mining and other lamps
2819 D. Swan, jun., Maryhill—Manufacture of zinc
2820 H. Trotter, Buglawton—Artificial fuel
2821 T. Ollis, Liverpool—Registering apparatus
2822 J. H. Brown, Romsey—Utilizing refuse animal matters

8th October, 1867.

2823 R. Garratt, Sheffield—Ball and other cocks
2824 E. Beningfield, Old Kent Road—Lifting machine
2825 J. Dean and T. Turton, Sheffield—Consumption of smoke
2826 J. B. Hulme, Manchester—Excavating
2827 J., S. A., G. E., and F. F. Reading, Birmingham—Securing stay busks
2828 A. Ticozzi, Bedford Square—Lotion for diseases of the eyes
2829 R. Beard, jun., Clapham Park—Stoppers for bottles
2830 F. Love, W. Armstrong, and L. Widdowson—Boring holes
2831 J. B. Brown, Bartholomew Lane—Railway carriage lamps
2832 J. Player, Glaisdale—Refining iron and steel
2833 E. G. Wolffgang, Staining Lane—Ribbons.—A com.
2834 R. Reid and E. H. Craige, Kilmarnock—Mattresses

9th October, 1867.

2835 A. Danilecki, Fitzroy Square—Electric baths.—A com.
2836 J. Barker, Todmorden—Consuming smoke
2837 J. H. Johnson, Lincoln's Inn Fields—Projectiles.—A com.
2838 H. Wallwork, Manchester—Manufacture of hats
2839 J. James, Ebbwvale, and F. Jones, Govilon—Manufacture of rails
2840 W. Potts, Handsworth—Gasaliers
2841 J. Speight, Bradford—Spinning
2842 R. Smith, jun., Belper—Mounting and driving millstones
2843 E. G. P. Thomas, Brentford—Dyeing black and gray
2844 T. Nelson, Edinburgh—Preparing surfaces of paper for drawing and for lithographic purposes
2845 W. Warren, Cheltenham—Cleaning machines

10th October, 1867.

2846 C. Avery, Tunkhannock—Increasing the safety of loading and discharging guns
2847 R. Brotherton and J. Maldron, Wolverhampton—Lamp posts
2848 T. Blackhurst, Birkenhead—Composition for ships' bottoms
2849 A. F. Hobhouse, Belgrave Square—Propelling vessels.—A com.
2850 W. R. Lake, Chancery Lane—Bunging barrels or casks.—A com.
2851 G. Twigg, Birmingham—Cork screws

11th October, 1867.

2852 A. M. Clark, Chancery Lane—Preparation of madder,—A com.
2853 R. George, Kilburn—Warming and ventilating buildings
2854 J. Withinshaw and J. E. Baker, Birmingham—Steam pumps
2855 E. Haigh, Leeds—Planking the bodies of hats
2856 J. C. Wilson, Lime Street—Rice unhusking mill
2857 J. C. Wilson, Lime Street—Steam boilers
2858 G. Davies, Lincoln's Inn—Manufacture of corsets
2859 J. Brönner, Frankfort-on-the-Maine—Gas burners
2860 W. H. May, Birmingham, and P. Graham, Oxford Street—Stoppers for bottles
2861 A. Helwig, Portman Square—Feed water apparatus for steam boilers
2862 R. A. Wright, Homerton—Heating
2863 E. Leitenberger, Cosmanos—Separating soluble from insoluble matters
2864 G. Angell, Clerkenwell—Portable fountain
2865 W. E. Newton, Chancery Lane—Preparing iron.—A com.
2866 W. Butler, Wolverhampton—Rolling of hoop or strip iron for brewers

12th October, 1867.

2867 H. B. Barlow, Manchester—Sewing machines.—A com.
2868 J. Buckingham and J. S. Blockley, Walworth Common—Regulating the feed of steam boilers
2869 C. H. Collette, Lincoln's Inn Fields—Staircases
2870 R. F. Bare and J. Thomson, Glasgow—Transmission of fluids
2871 J. B. P. A. Thierry, Paris—Smoke-consuming apparatus for steam boiler and other furnaces
2872 H. A. Dufrene, Paris—Decorticating grain
2873 R. Canham, Clerkenwell, and J. Thomson, New Wandsworth—Stoves and ovens
2874 E. Leitenberger, Cosmanos—Treating madder
2875 H. Forman, Chellaston—Wheels of traction engines
2876 J. Drabble, Sheffield—Securing handles of cutlery
2877 J. H. Johnson, Lincoln's Inn Fields—Knitting machines.—A com.
2878 B. Nicoll, Regent Street—Economical construction of buildings
2879 W. R. Lake, Chancery Lane—Electric telegraph apparatus.—A com.

14th October, 1867.

2880 J. C. Pearce, Bradford—Furnaces and fire-grates
2881 D. C. Blacke, Belfast—Spinning and twisting yarns
2882 E. Ward, Manchester—Hats
2883 W. Gadd, Nottingham, and B. Walker, Lenton—Manufacture of narrow fabrics
2885 W. Redgate and T. Marriott, Nottingham—Manufacture of lace in twist lace machines
2884 M. Fitzpatrick, Lincoln's Inn—Preventing accidents on railways
2886 H. N. Maynard, Crumlin—Bridges
2887 W. R. Lake, Chancery Lane—Loading ordnance.—A com.
2888 W. R. Lake, Chancery Lane—Revolving batteries.—A com.
2889 M. A. F. Mennons, Paris—Signalling on railways.—A com.

15th October, 1867.

2890 H. A. Bonneville, Paris—Superheating steam.—A com.
2891 H. A. Bonneville, Paris—Threading needles.—A com.
2892 M. Vogl and H. V. Dyk, Castle Street—Muffs combined with bags
2893 A. Aitchison, Peckham—Manufacture of hydrocarbons
2894 T. H. Baker and T. Woodroffe, Tonbridge—Treating sewage
2895 M. Samuelson, Hull—Sewing machines
2896 W. R. Lake, Chancery Lane—Propelling railway carriages.—A com.
2897 H. A. Leveson, Belgravia—Pack saddles

16th October, 1867.

2898 B. Latham, Croydon—Distributing sewage over land
2899 A. M. Clark, Chancery Lane—Producing motive power.—A com.
2900 A. and A. C. M. Prince, Charing Cross—Telegraphic communication
2901 F. D. Frost, London Street—Drawing and spinning rollers
2902 C. Tinet, Paris—Chairs
2903 E. Gessner, Aue—Fulling stocks
2904 W. E. Newton, Chancery Lane—Preparing wood.—A com.

17th October, 1867.

2905 D. Pidgeon and W. Manwaring—Reaping and mowing machines
2906 J. Oxley and G. Wilson, Frome—Cleansing casks
2907 W. B. Adams, Blackheath—Locomotive engines
2908 M. Wilkin and J. Clark, Paddington—Signalling upon railways
2909 W. R. Lake, Chancery Lane—Electric telegraph apparatus.—A com.
2910 E. Shaw, Manchester—Coverings for perambulators
2911 R. C. Ross, Manchester—Mechanism for cutting paper
2912 J. Rives, Paris—Casting metals
2913 C. S. Lynch, Massachusetts—Governors for steam.—A com.
2914 L. Hamel, Nottingham—Clipping figured net
2915 O. C. White, Massachusetts—Chairs
2916 T. Bell and J. Richardson, Lincoln—Hulling rice
2917 G. M. Wells, Barnsbury—Manufacture of boots and shoes
2918 J. Bannehr, Exeter—Supplying deodorizing matter
2919 J. Cubitt, Brixton—Preserving stone and other substances from decaying
2920 W. Tredgold, Blackwall, and J. M'Neil, Bromley—Steam boilers and furnaces

SOME OF THE REMOTER EFFECTS OF STEAM LOCOMOTION.

It remains for some future Macaulay to trace, with a clear eye and firm hand, the wondrously deep and searching revolution that *free* locomotion, conferred upon mankind for the first time by the steamship and locomotive, is producing, and is yet to produce—a revolution which not only has already reached the physical condition of mankind, and is changing every visible and external relation of life, but which is involving also intermediately every political, moral, social, religious, and hygienic condition of mankind. No more obvious result, partly already obtained, partly yet to be completed, has resulted from the vast accession of free locomotion, than the tendency to equalize amongst all peoples and nations the produce and fullness of the earth. Orissa famines will not be heard of when once the railway has penetrated the East, and its powers have become understood. Already this effect of the more uniform diffusion of the power to seek for new fields of labour or employment, on the one hand, and of commodities tending to improve the comforts, and with these to exalt the condition of men and of communities, has shown itself in a sensibly improved condition of all classes in Europe and America, and especially of the lower classes. Even a cursory examination of the statistics of health and disease in the great Continental countries, respectively, for the whole of the present century, is sufficient to show how much improvement has been produced. Doubtless many other causes have concurred to the one result; more than forty years of peace is amongst these, for had there been no such interval of leisure and of growing attention to the arts of peace, the locomotive and steamship might not even yet have been in existence. So, too, manufactures have given comfortable and cheap clothing to those whom our fathers remember as only clothed in squalid rags, in such costume by necessity, as we see on the lower orders of London in Hogarth's vigorous sketches of their life and conversation a century or so ago. The repeal of the corn law has had much to do with improving the condition of every soul in Great Britain; but it scarcely would have been repealed when it was, had not experience been already felt of the power of rapid and reliable transport of foreign grain, acquired by the railway and the steamship.

The railway again has been the real, though scarce felt agent, that has practically done away with the passport system all over Europe, and which will in the end abolish that most absurd, useless, and vexatious system of custom-house examination of travellers or passengers' baggage—a system of which any man who travels much abroad must be convinced that "the game is not worth the candle;" that the tribe of half-idle good for nothings that constitute the *douane* of most foreign countries, as well as the more respectable custom-house officers of our own country and of France, cost a vast deal more to pay them than all the smuggling that could or would be effected by all the travellers they are set to watch and enabled to delay and vex. This, we believe, is just as absolutely true upon the great scale as upon the small. Nothing can evidence it more forcibly than the revelations made by Mr. Lumley in his able report on the Russian overland tea trade, with respect to the goods trade across the frontier from Prussia into Russia. With a tariff almost prohibitory if honestly paid, to any trade at all, and with a cordon of custom-house officers, armed with and executing their *apparent* powers of repression of smuggling with the apparatus and with the rigour of a military state of siege, what is the fact? That the system of smuggling, with the connivance and even help of the *douane*, is such, and so large and complete, that about *sixty per cent.* of all the goods that cross the frontier get into Russia without paying duty at all. Mr. Lumley gives one striking example:—A case in which *one hundred casks* of Rhenish wine which crossed the frontier was entered in the Russian official books as *forty* only, and duty paid on no more. This instance was traced from point to point in the official channels so as to leave no question as to the guilty cognizance of the authorities.

However, our immediate point is to notice the yet more curious hygienic instances of change, which may be in great part attributed to the results in improved comforts due so mainly to free locomotion. As one example we allude to the decrease noticed by physicians in the occurrence of gout all over the civilized world. In a remarkable memoir not long since published on the subject by Dr. Charcot, he points out from statistic sources that this disease, which, like stone and gravel, was in our grandfathers' days common, and common to all ranks and classes (being by no means confined to the wealthy and luxurious, as is our popular notion at present, but found even amongst paupers in England living on parish fare) has been for the last half century or so steadily on the decline all over Europe. He shows that in some large cities it has become within the last few years absolutely extinct, and he predicts the probability of its disappearing ultimately from the list of human ailments, never to return with the same symptoms, and never to return at all, unless some grand cataclysm in Europe shall restore the ignorant and irregular living, the bad food, and the want of it, and the general ignorance of hygiene, to the concurrence of which in past times he attributes its existence.

In his view of the slow extinction of gout as a human disease, Dr. Charcot is supported by the testimony of Owen and Fuller in England, of Coley in Holland, and of Lebert in Switzerland. What other diseases may be destined in like manner to hide their heads in succession through the improvements in the average comforts and condition of European men, it is too soon perhaps to speculate; but that it will affect others there can be but little doubt. All that depend on dirt, discomfort, and bad food must yield to the rail.

That the cattle disease, which was "stamped out" after its inroad into Great Britain not long ago, we may easily see, had been impossible were it not for the rapid means of communication and for the transmission of intelligence we possess, and for the means which the railway afforded of stopping the trade in live cattle, and substituting that in dead meat carried by rail. Fifty years ago our great cities would have been starved, had the trade in live cattle been interdicted. Beef killed in Cheshire would have been unfit for food by the time it reached London. It has been remarked by the late Dr. Whewell, we believe, that every great advance or improvement in the external condition of men has been preceded by the discovery of some new instrument of power. The remark need not be limited to external condition only, for as surely as gunpowder put an end to the oppression of feudalism, so did printing produce the possibility of the Reformation—that grand first riddance from the oppression of priestcraft and lying. It would not be easy to fix how far locomotive power by land and sea have been auxiliary agents to the next grand blow at priestly assumption and tyranny, which even now seems impending over these at their European central seat of Rome.—Ed.

THE NEW HUTCHESONTOWN BRIDGE AT GLASGOW.

For some years past the insecure condition of the present bridge across the Clyde at Hutchesontown has attracted the attention of the Clyde Bridges' Trustees, and between two and three years ago Messrs. Bell & Miller, engineers, were instructed to report upon the existing bridge, which they found so dilapidated, particularly at the foundations, that they very wisely advised its complete removal and to replace it by a new bridge. The engineers were after this instructed to prepare plans and designs for the new bridge; and to Messrs. Bell & Miller we are indebted for a full set of the drawings, from which the illustrations have been prepared. The elevation, fig. 1, shows at a glance a structure of great grace and elegance of design, whilst the central arch is more effectually shown in the detached elevation, fig. 3, where the ornamental detail is more prominent than it was possible to produce in so small a scale as that to which fig. 1 is drawn. It is expected that the removal of the existing bridge and the completion of the new one will occupy about two years from the commencement of operations. The plinths of the piers of the old bridge are shown in dotted lines at fig. 1.

We understand that the Act of Parliament authorizing the new bridge provides only for the expenditure of £39,000 on its construction. The designs, however, were tendered for, and the lowest offer was £54,000; the result of which was that the authorities determined to abandon these designs, and instructed the engineers to prepare something far simpler and consequently less costly. Messrs. Bell & Miller have not, however, greatly altered the general plan of the bridge, but by maintaining the same external appearance they have modified the structural features, so that the lowest tender is by these alterations reduced to £48,900; this, however, is still £9900 in excess of the parliamentary estimate. We are glad, however, and have reason to congratulate the Trust that they have not abandoned a graceful and highly ornamental structure for one that, from the very lowness of its cost, must in all probability have been a lasting public eyesore, of which there is more than one frightful example spanning the river already. The abutments are to be raised on cylinders, not on piles, as some of

the members of the Trust proposed; but Messrs. Bell & Miller have reduced the number of them from sixteen to twelve, which they deem sufficient to insure the stability of the bridge. The facework of the masonry is to be granite. The existing bridge is extremely inconvenient on account both of its steepness and narrowness, the gradient being 1 in 22, and the breadth but 34 feet. In the new bridge, however, great accommodation is provided for in a roadway 60 feet broad, and a very flat gradient of but 1 in 70, merely enough rise to impart a graceful

Fig. 1.

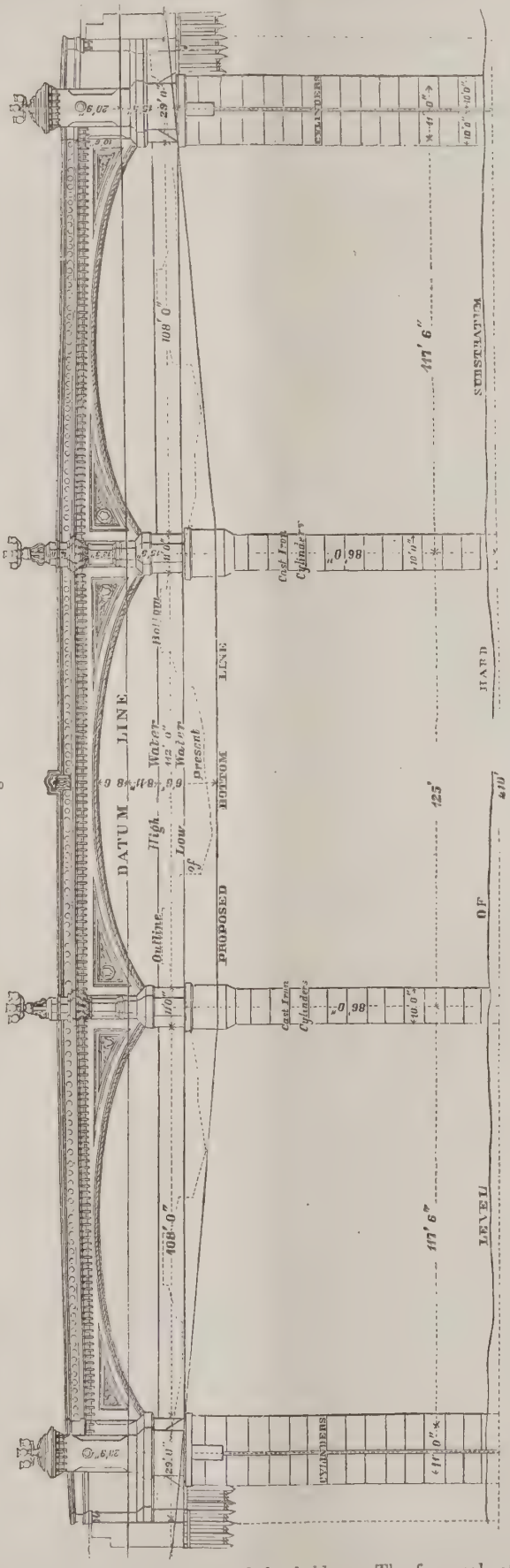
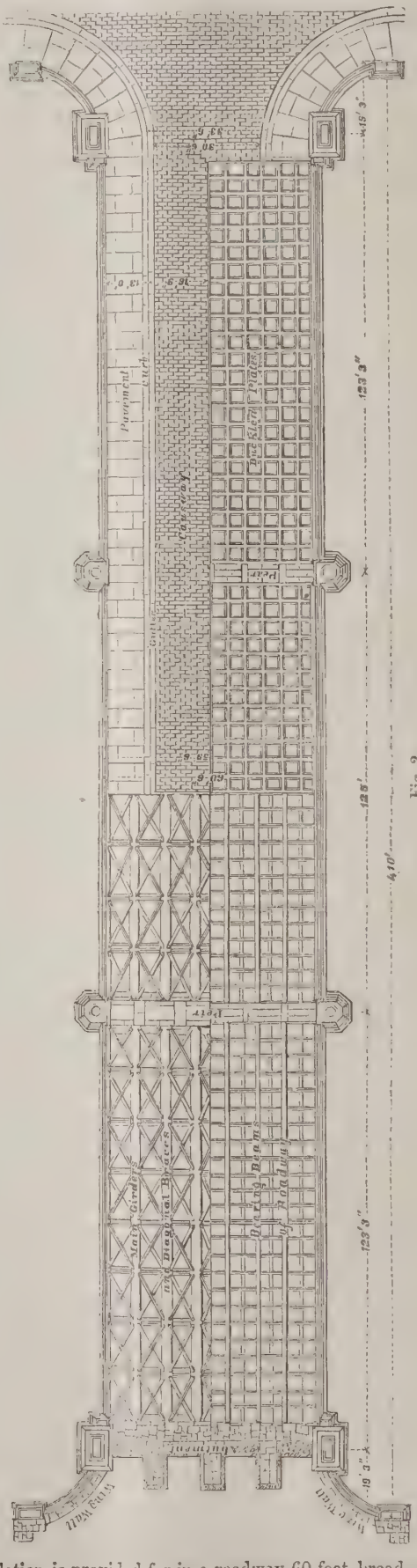


Fig. 2.



appearance. The total length when completed will be 410 feet, divided into three arches, the two sides being 108 feet, and the centre one 114 feet span.

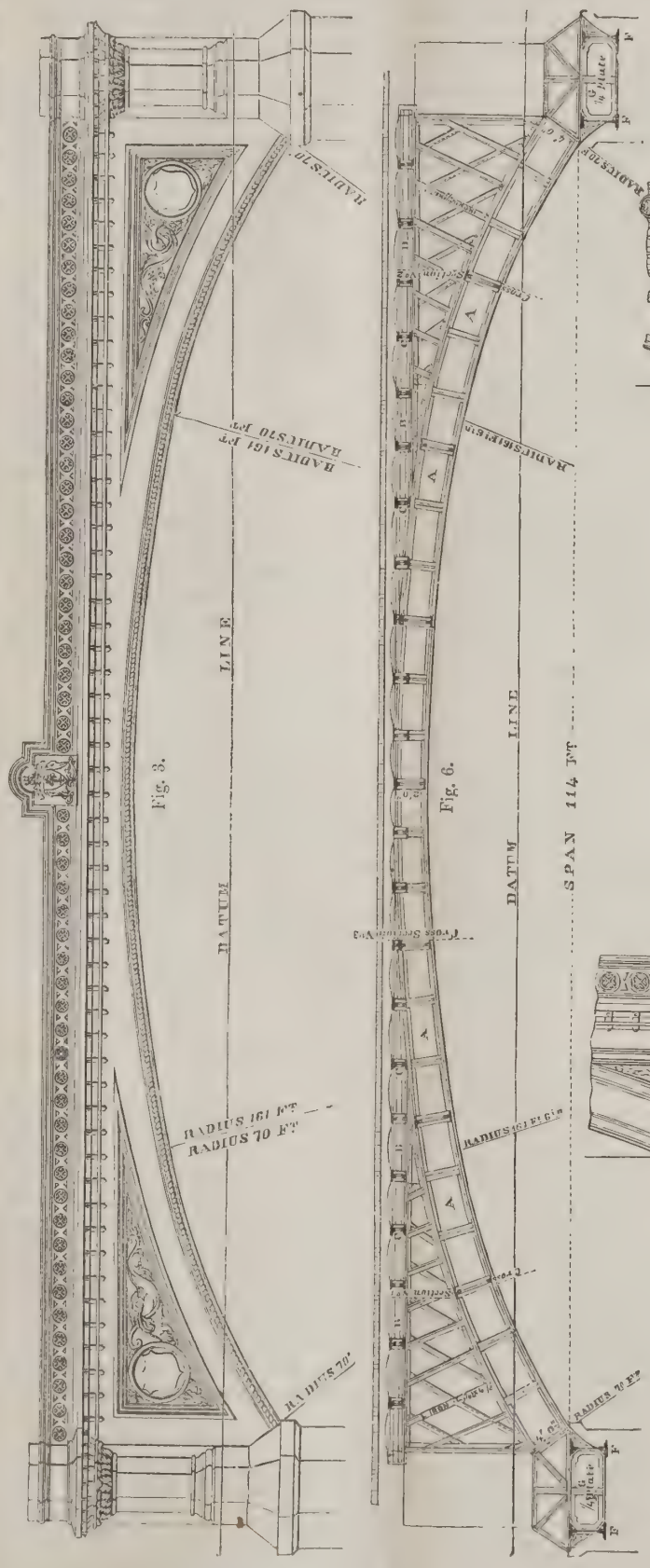


Fig. 4.

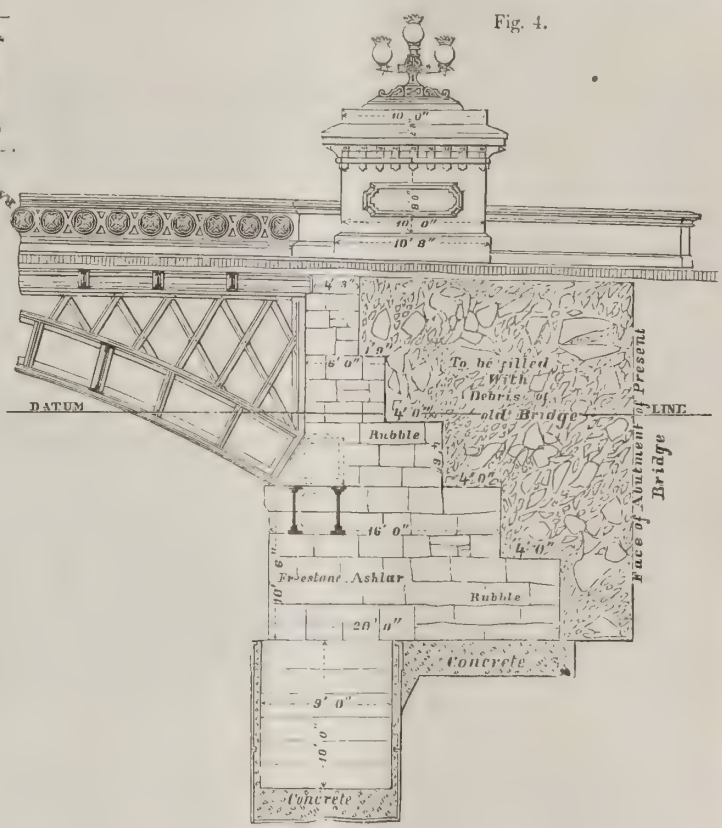
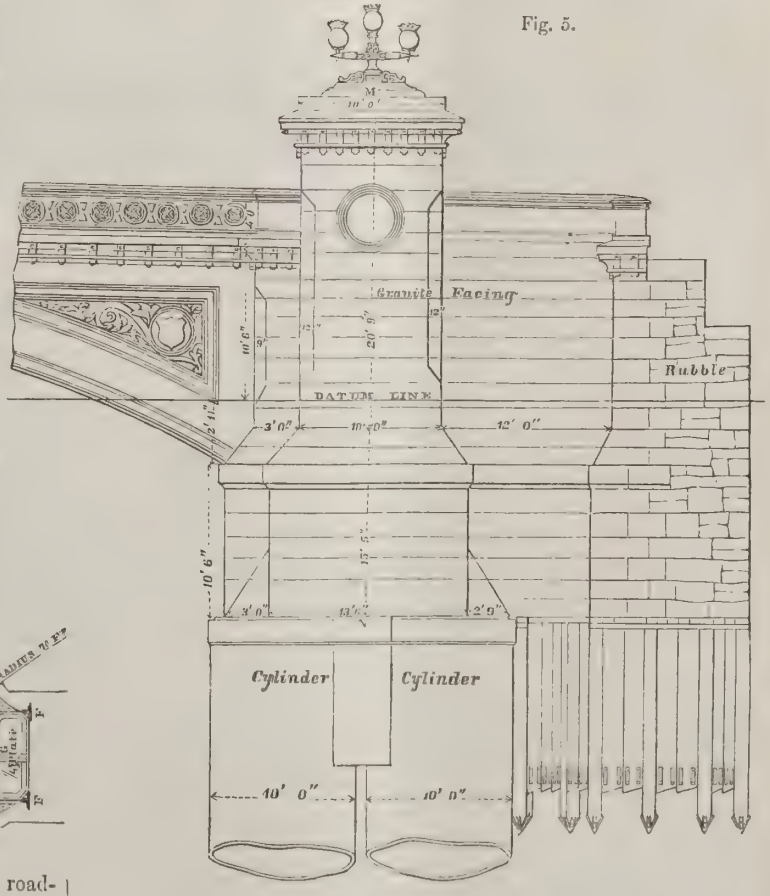


Fig. 5.

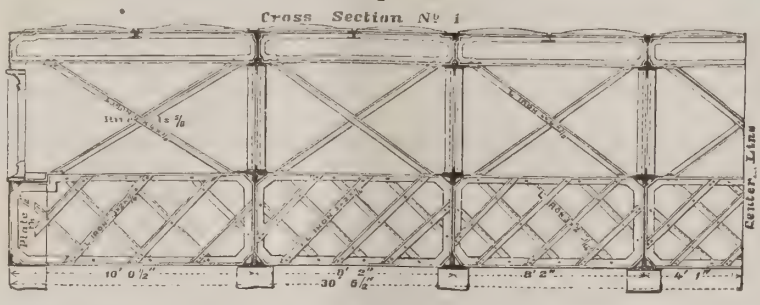


Of the illustrations, fig. 1 is a side elevation; fig. 2 a plan of roadway; fig. 3 an elevation of the centre arch; fig. 4 an elevation of abutment; fig. 5 a section of abutment; fig. 6 an elevation of interior girder and framing of centre arch; fig. 7, cross section No. 1; fig. 8, cross section No. 2; fig. 9, cross section No. 3; fig. 10, section of arched girder, A (centre of span); fig. 11, section of longitudinal girder, B; fig. 12, section of transverse beam, C; fig. 13, section of transverse girder at springing, F; fig. 14, section of connecting girder, G.

ABUTMENTS.

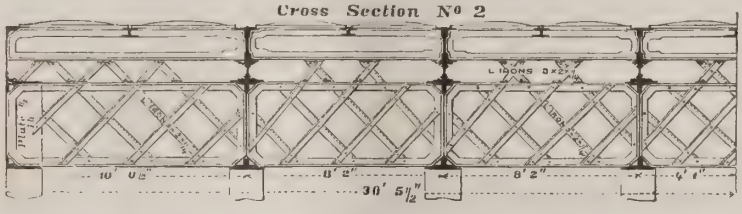
The wingwalls of the abutments are to be founded on timber piling of Memel or American red pine connected at the top by cross-bearers

Fig. 7.



and planking, the whole of which is to be creosoted under pressure, the quantity of oil to the cubic foot to be not less than 10 lbs., and the piles shod with wrought-iron shoes having cast-iron points. The cross pieces

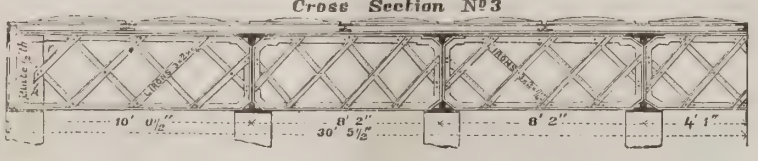
Fig. 8.



are to be fastened down to the tops of the piles by 1-inch wood screws, each 2 feet long, and the planking fastened to the cross bearers by 8-inch spikes.

The side elevations of the abutments are to be faced with the best

Fig. 9.



white Scotch granite returning 2 feet under the arches, the parapets of the abutments are also to be of the same material, axed over on the face and beds, and closely jointed. The freestone not obtained from

Fig. 10.

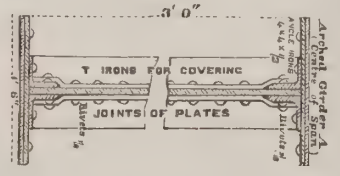
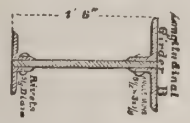


Fig 11.



the old bridge is to be brought from the quarries at Nitshill or Giffnock. The ashlar masonry, chisel drafted on face, to be laid and jointed in Portland cement, and the stone square-dressed throughout, the upper

Fig. 12.

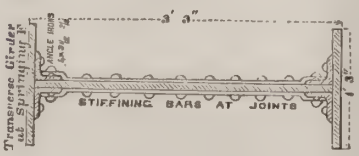
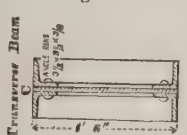


Fig. 13

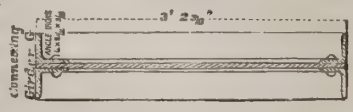


and under beds being chamfered 1 inch. The masonry in the cylinders is to be built dry by means of wrought-iron coffer dams fastened to the top and rising 6 feet above high water. The rubble masonry is to be laid in courses corresponding with the ashlar facing and grouted with hot lime at every course; the two face courses of ashlar immediately under the springing of the arches at the piers and abutments will have the stones united by joggles of granite 4 inches by 4 inches by 4 inches set in cement. The mortar to be used is to be of one part hydraulic lime, half part iron mine dust, and one part sand; the same, in fact, as for the concrete, except that no gravel or stone chips are to be used.

PIERS.

The piers are to be constructed and faced, similar to the abutments, with the best white Scotch granite, returning 2 feet under the arches; whilst the inside elevations of the parts of the piers above the pavement are intended to be similarly faced. The piers are to be surmounted by four red polished shafts, each in one block, and four panels of a similar granite will be inserted into the pedestals of the piers, and four into the pedestals of the abutments facing the roadway; these shafts and panels are to be highly polished, and will present a striking contrast to the ashlar work of freestone. The chief part of the stone of the old bridge is intended to be used for the masonry of the new bridge, the stones being redressed.

Fig. 14.



It is intended to remove the old bridge entirely down to the level of the proposed bottom line, and deeper still if necessary, with the exception of the abutment walls—the old timber piles on which the piers rest being drawn or cut down, as is found most desirable. At the same time a great quantity of loose stones (riprap), which has been thrown around the piers to protect them, from time to time, will have to be removed.

FOUNDATIONS.

In these great outlay will be necessary, on account of the untrustworthy condition of the strata underlying the river bed, there being no less than some 89 feet of sand before the clay is reached. Cylinder foundations of this kind have, however, been recently put down in the Clyde for the Union Railway Bridge, which we have before noticed.* The cylinders are to be filled with concrete, composed of ground hydraulic lime, mine dust, sand, and gravel or quarry chips; the proportion of these ingredients being—

	Parts.
Ground lime,	1
Ground iron mine dust,	½
Sand,	1
Gravel or quarry chips,	3

The lime is to be that from Arden or Davieland (a blue lias), and the sand the sharpest in the locality.

It was originally intended to sink three cast-iron cylinders under each pier, and five under each abutment. This plan has been modified, we believe, to two under each abutment, reducing the number of cylinders from sixteen to twelve. Those cylinders 10 feet in diameter are to be in lengths of 6 feet 9 inches, and those 13 feet in diameter, 5 feet 9 inches and of a uniform thickness of 1⅛ inch, except at the lower end, where the thickness is to be 2 inches for a depth of 1 foot, and tapered to a point, so as to cut the strata with facility. The joining flanches are to be 3½ inches broad, bolted together by ¾-inch screw bolts, 12 inches apart, and stiffened by angled fillets, also 12 inches apart.

The wrought-iron plates to be of the best boiler quality from Glasgow, Blochairn, or Parkhead, and the bars of "best;" each plate to be capable of sustaining a tensile strain of twenty-two tons per square inch. The ties to be of wrought iron 3½ inches in diameter, placed at the level of the top of the cylinders so as to prevent the flat stone arches from spreading, screwed up to the cast-iron angled plates, and bolted down to the rubble masonry in the cylinders by 3-inch bolts, each 6 feet long, recesses being cut in the bottom of the arch stones to receive the ties, which are to be bedded in mortar, so as to exclude water thoroughly; and at the same level wrought-iron cross ties, firmly screwed together, will connect the tops of the iron piles. All the superstructure of the bridge will be of wrought iron, except the ornamental parts, which will be of cast iron. Two longitudinal wrought-iron

* Vide *Practical Mechanic's Journal*, vol. ii., Third Series. pp. 75, 76.

girders immediately below the springing of the arches are to stretch across each pier and abutment, connected together by cross girders, on which the arched girders of the bridge will rest. These girders, as the masonry is being built around them, will be run in with Portland cement.

ARCHES.

There are to be eight malleable-iron arched girders in each arch, similar to that shown in elevation at fig. 6, connected at the springing to the bearing flanches of the girders and the piers, as well as the abutments, by ¾-inch bolts. The web of the arch portion of these girders is to be made of ½-inch plate, and the top and bottom flanches each of two thicknesses of ½-inch plate, making the thickness of each flanch 1 inch. These plates will break joint, and be connected by ½-inch joining plates 2 feet long and the full breadth of the flanch. The plates of the outer girders will be connected by three rows of rivets, and the inner girders by four rows, except through the joining plates, where there will be six rows. The portion of the girder which will support the roadway will have joining plates 18 inches long. The roadway will be sustained by buckled plates, fastened to the flanches of the girders and cross bearers by ⅜-inch rivets. The whole of the upper surface of these "buckled plates," after being put in position, are to be coated with hot gas tar, and over that a layer of concrete. After this has been levelled to the under side of the causeway and pavement, it will be covered with asphalte ¾ inch thick. The carriage way is to be formed of granite pitched paving, each stone of a depth of 8 inches, 4 inches thick, and 9 inches to 14 inches in length, bedded in mortar and grouted with hydraulic lime and sand in the proportion of one of the former to two of the latter. The gutters and curbstones to be of white granite, each 18 inches in breadth, rough axed, and the face in lengths of 5 feet.

The outside girders are to be relieved by cast-iron work of an ornamental character, a cable moulding, fastened to the girders by screw bolts, following the outline of each arch. The spandrils will be filled in with panels inclosing scroll work and armorial shields, which are to be ornamented with armorial bearings. The centre of the bridge at the parapet is to be ornamented by panels bearing the arms of the city of Glasgow. The cylinders are to receive a coat of red lead or of Pulford's magnetic paint, and the 13-feet cylinders two extra coats, and then be painted stone colour, similar to the entire superstructure of the bridge. The cable moulding round the arches, the outer moulding of the panels in the spandrils, the bosses on the ends of the consols, and the armorial shields and panels, are to be bronzed and the arms gilded. The lamp standards, also, are to be bronzed and picked out with gold.

The contract for the works has been let to Messrs. Kenna, Donald, and Wilson, of the Abbey Works, Paisley.—V. D.

ON SOME POINTS OF PRACTICE IN IRON FOUNDING.

No. XXII.

American Gun Founding.

THE American iron founder purchases at the same time all the iron necessary for making all the guns for which he has received an order, and fixes on the method of casting which he intends to follow. The (government) superintending officer verifies the samples, and follows all the details of manufacture. The first gun poured is submitted to the mechanical test, and to that by long-continued firing. If the proof is satisfactory all the guns of the series are cast according to the same process, and the metal of each gun is subjected to mechanical proof. Finally, if the mechanical proof shows that the metal has preserved the same qualities up to the end of the series, the whole are accepted, subject only to the ordinary proof, consisting of a few rounds with one shot or shell, and a quantity of powder but little more than the service charge.

Yet these rules have only been adopted in America within the last few years. During the whole period of the experiments which we have already detailed, the guns were not submitted to any firing test; it was considered sufficient if they were free from flaws, and if the metal possessed the required tenacity. Two hundred guns have been accepted on these conditions. All the efforts of artillerists and founders were directed to obtain iron of the greatest possible tenacity, and they were so far convinced that the strength of the gun is proportional to the tensile strength of the iron, that, after having attained enormous tenacity by various means, they considered any firing test as superfluous.

Some idea may be formed of the improvement in the iron by the new processes, by comparing the strength and density of the metal of cannon cast in 1841 with those of guns cast in 1851, before the application of the more fully perfected methods.

Guns.	Means.	
	Density.	Tensile Strength.
		Lbs. per Square Inch.
Cast in 1841,	7·148	23,638
Cast in 1851,	7·289	37,774

As an exceptional case, and for a purpose entirely different from determining the strength of the guns cast by the new processes, a great number of rounds were fired from some of these pieces.

The results of this practice are given in the subjoined table. We have added the proofs of some guns cast in 1841, but not included in the 2808 pieces before mentioned. Thus tables previously and now given contain the results of all the pieces which have been tested both by firing and mechanically, all those at least with which we are acquainted.

Number in order.	Calibre and Number of the Pieces.	Class.	Specimens Taken from the Pieces.		Test Bars.		Number of Shots Fired.		Greatest Charge.			Pieces which did not Burst.	Place and Year of Manufacture.
			Density.	Tenacity.	Density.	Tenacity.	Service Charges.	Extra Charges.	No. of Rounds.	Weight of Powder.	No. of Balls.		
1	6-pounder gun, No. 3,	0	7·369	35,575	—	—	—	23	1	3	16	—	Boston, 1848.
2	" " No. 4,	0	7·378	32,689	—	—	—	27	6	3	16	—	" "
3	" " No. 8,	0	7·278	30,187	—	—	—	25	3	3	16	—	" "
4	8-in. Columbiad, No. 19,	0	7·333	36,497	—	—	500	11	1	20	11	not burst	" 1844.
5	10-in. " No. 1,	0	7·298	33,344	—	—	94	—	—	—	—	—	" 1846.
6	8-in. " No. 3,	0	7·288	37,989	—	—	73	—	—	—	—	—	" "
7	10-in. " No. 5,	0	7·290	37,122	—	—	20	—	—	—	—	—	Pittsburg, 1851.
8	6-pounder gun, No. 5,	1	7·203	—	7·225	25,969	—	31	9	3	16	—	Boston, 1844.
9	" " No. 6,	1	7·196	30,234	7·263	29,143	—	34	12	3	16	—	" "
10	" " No. 7,	1	7·213	32,231	7·274	27,755	—	38	16	3	16	not burst	" "
11	32-pounder (Sea),	1	7·230	32,000	—	—	—	51	1	25	7	—	" 1845.
12	24-pounder (English),	1	7·205	28,067	—	—	1000	—	—	—	—	not burst	—
13	8-in. Columbiad, No. 64,	1	7·276	26,367	7·331	24,583	729	—	—	—	—	—	Boston, 1844.
14	10-in. " No. 67,	1	—	—	7·379	22,402	600	10	1	22	4	—	" "
15	8-in. " No. 33,	1	7·277	26,837	—	—	500	4	1	10	5	—	West Point, 1845.
16	10-in. " No. 2,	1	7·416	29,181	—	—	500	9	1	36	9	—	" "
17	8-in. "	1	7·247	29,423	—	—	2582	—	—	—	—	not burst	Pittsburg, 1846.
18	" " No. 1,	1	7·221	27,014	—	—	85	—	—	—	—	—	" 1849.
19	" "	2	7·220	22,989	—	—	800	—	—	—	—	—	" 1846.
20	18-pounder gun (old),	3	7·384	16,849	—	—	—	4	1	9	4	—	—
21	32-pounder (English),	3	7·040	18,145	—	—	—	1	—	—	—	—	—
22	18-pounder,	3	7·010	22,900	—	—	51	—	—	—	—	—	West Point (hot blast iron).
23	32-pounder, No. 61,	3	7·030	16,313	—	—	—	16	16	8	2	—	Richmond, 1844.

In this table the guns are classified on the same considerations that determine the classification in service. Besides this we have set a certain number of guns of the first class apart and called them Class 0. We have put in this class all the pieces, the metal of which had a density of more than 7 275, and a tenacity of more than 30,000 lbs. per square inch. These guns consequently should have proved the strongest. All the pieces were proved at various periods; some with ordinary, and some with extraordinary charges. The comparison of the strengths of the different classes is less easy here than in the case of the table previously given in a former article. Yet we have been able to draw some definite conclusions.

Four guns of Class 0 were proved with service charges; three burst after a few rounds. Seven guns of the first class were proved similarly, of which two burst, one at the 85th, and the other at the 729th round. The second-class gun burst at the 800th round with service charges. Lastly, one gun of the third class, made with hot-blast-iron, burst at the 51st round with service charges. It appears, therefore, that the guns of Class 0—that is to say, those the metal of which showed the maximum resistance to mechanical proof—turned out to be no stronger than the pieces of the third class.

In the proof with increased charges the guns of Class 0 gave a higher degree of relative resistance, yet not so much so as those of the first class. In fact all the 6-pounders of Classes 0 and 1, with the exception of No. 7 of the first class, burst with a charge of 3 lbs. of powder and sixteen balls. The three of Class 0 burst respectively at the first, sixth, and third round. The piece No. 7 of the first class fired sixteen rounds without bursting, and it was afterwards subjected to the hydrostatic test of which we have given the results.

The 8-inch Columbiad, No. 19, was exceptional among the guns of Class 0, as regards its resistance. This piece stood, without bursting, 500 rounds with service charges, and eleven rounds with increased charges, the last of which was 20 lbs. of powder (double the service charge) and eleven balls. Consequently it withstood a greater number of rounds with the increased charges than the Columbiads of the first class. Among the guns of the first class the 32-pounder sea-service gun withstood a severe proof—fifty-one rounds with extra charges, the last of which with 25 lbs. of powder and seven balls burst the piece.

The guns of the third class proved weak with the increased charges. One burst with a charge of one-fourth and two balls, and another with a charge of one-half and four balls. The third burst at the first round of the ordinary proof then in vogue in the American foundries. It was a gun sent from England as a model both for form and for quality of metal.

The 6-pounders Nos. 5, 6, 7, and 8, had been cast from the same reverberatory furnace, the first half an hour after the complete liquefaction of the metal, and the others respectively at 1, $2\frac{1}{2}$, and $3\frac{1}{4}$ hours after the first. The results of the proof show that the strength of the pieces increased with the duration of fusion, as well as the density and tenacity of the metal, up to a certain limit corresponding to No. 7, which showed the maximum resistance in firing, while No. 8, although denser, was the weakest of the four.

This example shows on a small scale what all the American experiments have shown on a great one, namely, that the strength of cast iron increases with the duration of fusion and in proportion as a whiter metal is obtained, but that this improvement does not hold good beyond a certain point, so that a very white metal, notwithstanding its great tenacity, does not produce very strong cannon. The results of the firing of the guns of Class 0, show that we may consider any sample as too white which has a density of at least 7·275, with a resistance of 30,000 lbs. or more. If the density is above 7·275, but the tensile strength less than 30,000 lbs., the metal may still produce good guns. This was shown by the 10-inch Columbiad, No. 2, a gun which with a density of 7·416, proved very strong under the firing test. It may be concluded from the foregoing that white cast iron is a cause of weakness, and one which cannot easily be explained either by the great density or the great tensile resistance of the metal, but which becomes apparent in proportion as these two factors increase, or by the effects of repeated or long fusion. The importance of understanding this cause of weakness is evident, since in many cases its influence is greater even than that of the tenacity of the metal. We are also in a position to state, that although in general this source of weakness increases with the density and tenacity of the metal, yet it does not always increase at the same rate. This results from a comparison of the 8-inch Columbiads, Nos. 19 and 1. The first of these guns undoubtedly belongs to Class 0, and the second to Class 1, and yet the first turned out to be astonishingly strong, and the second very weak. We have in former papers, given upon fundamental principles the full explanation of all this so-called improvement by long-continued fusion, about which the American experimenters make so much ado, and said all that need be said about it. We here, therefore, merely refer the reader back to previous papers of this series.

Of Interior Strains.—It is known that white iron contracts much more in cooling than gray iron. It is the effect of this property on the strength of cannon that we shall now inquire into, but first a few general considerations will not be out of place.

Imagine two rectangular flat bars of cast iron absolutely identical, and suppose that each of them be acted on by a tensile force in the direction of its length, these two bars can withstand the same force, and each of them will break when its elongation shall exceed a certain limit. Call this limit u, and P the force which produces it. If we solder the two bars face to face and apply to each a force, P, each bar will undergo an elongation, u, and the force, 2 P, will be necessary to give the double bar the elongation, u, and beyond this the least increase of force will produce rupture. But if at the moment of uniting the two bars, one of them be subjected to a force which stretches or compresses it, the result is entirely different. Suppose, for example, that one of the two bars be subjected to a force which stretches it nearly to the point of rupture, and that in this state it be closely soldered to the other bar; then if the elongating force be removed the first bar will tend in virtue of its elasticity to recover its original length; but in so doing it will actually produce a compressing force in the second which will resist it in virtue of its elasticity. Equilibrium will be established between the two bars when the compressing force produced by the first shall be equal to the resistance to compression of the second. But then the first will still be in a state of tension, and the second in a state of compression, and the compound bar will be only able to support a force considerably less than 2 P. In fact we will suppose that the double bar be submitted to a tensile strain, and we shall see how the elongation of the first bar can take place. In the state of equilibrium we have said that this bar is already stretched; its length will increase by the action of the applied force, and by the elastic reaction of the second bar, which endeavours to recover its natural state, this double effect will continue until the first bar assumes the length it had at the moment of being soldered to the second, and then the latter having regained its original length, will no longer help the applied force. From this moment the second bar will come to the aid of the first, yet when the first shall have attained its limit of elongation, the second will not have nearly reached this point. The first then will be broken before the second will have exerted all the resistance of which it is capable, and the total resistance will only be equal to the resistance of the first, plus a part of the resistance of the second. If we suppose that the first bar be stretched to the limit u, at the moment of being soldered to the second, it is plain that when the applied force shall have brought the latter into the same condition, the second will only have resumed its natural state; therefore it will contribute nothing to the resistance of the compound bar, which will be equal simply to P. The diminution, then, of the resistance of the double bar arises from the fact of the two members not resisting simultaneously, or else from their not contributing equally to the total resistance. If instead of subjecting the first bar to a stretching force before soldering it to the second, it be caused to dilate by the action of heat, the effect is precisely the same. The expansion of cast iron at 100° (C) being equal to the limit of elongation which immediately precedes rupture: to heat the first bar to 100° before uniting it to the second, is the same thing as to diminish the resistance of the compound bar to one-half. A still higher temperature would diminish the resistance in like proportion, so that it might happen that the first bar would break without the application of any exterior force, solely from the resistance offered by the second bar to the contraction of the first.

Again, if we suppose that the first bar be compressed, either mechanically or by cold, at the moment of being soldered to the second, we have the same tensions reversed, and the total resistance will be diminished in the same proportion.*

* These are the statements of views very well known and exactly investigated in Europe, but we may not omit to notice that, as here stated by the American experimenters, some of their conclusions are by no means well founded—*e.g.*, though the elongation of cast iron by 100° Fahr. is the same in some examples as by a strain of 7 tons or so per square inch, the conclusions they deduce from the fact are not, in fact, true to nature.

But these same internal strains are actually produced in the mass of a gun when the metal solidifies by cooling, for the layers which cool in succession are always at a higher temperature than those which are already solid. Nevertheless the effect is not quite the same in the hollow cylinder as in the double bar; for while the resistance of the latter is always lessened by internal strains, the resistance of a hollow cylinder subjected to internal pressure (like that from the gases of gunpowder) may be greater or less than that of another hollow cylinder in which internal strains do not exist. To understand this perfectly, it will be necessary to enter somewhat in detail into the resistances of cylinders.

Let there be a hollow cylinder subjected to an internal pressure, P; and suppose that in consequence of this pressure the cylinder stretches slightly, in consequence of the elasticity of the metal. Let us consider the walls of the cylinder as divided into a great number of concentric layers; each of these layers will expand and its radius will increase; it will then give rise to an elongation of the metal in the direction of the circumference of each layer. But in virtue of the elasticity of the metal, each layer so stretched tends to recover its original dimensions, and therefore reacts on the pressure, P. The force with which each layer reacts is proportional to the expansion or elongation of its radius. But any one layer cannot stretch beyond a certain limit without rupturing; and this limit for cast iron is about 0·0016 of its original dimension. For a cannon to withstand the pressure of the gases of the powder, it is evident that no layer shall reach this limit.

Suppose that all the layers which make up the thickness of a cannon resist a pressure, P, together, the first or interior layer will expand, but in virtue of its elasticity will tend to recover its original dimensions; it will establish equilibrium then with a certain part, p, of the whole pressure, P. The second layer will consequently only be visited with a pressure $= P - p$; consequently it will be less stretched than the first, and will establish equilibrium with a part of P less than p_1. The third layer will only receive a pressure $= P - (p_1 + p_2)$. It will therefore be less stretched than the second, and will establish equilibrium with a part, p_3, of P less than p_2, &c, &c. It is the first layer, then, which plays the greatest part in the resistance of the gun; and this resistance is the same as the sum of those of all the layers $P = p_1 + p_2 + p_3 \ldots = \Sigma p_1$. The resistance of a cannon, accordingly, could be considerably increased if the outer layer were compelled to take a greater part in the total resistance. This is what is done when one or two layers of wrought iron are forced on to the gun. In fact, the outer layers, being in a state of tension, compress the inner ones even before the force, P, begins to act. Before, then, that this force can begin to act, it must overcome the compression of the interior rings; and it is only afterwards that these rings can begin to expand. The inner layers, then, at this instant retain their whole resistance. As to the rings which have expanded before the action of the force, P, this force will cause them to expand still more, and so their final expansion will be greater than those of a cannon, not hooped, of the same dimensions, and therefore they take a greater part in the total resistance. Nevertheless, the forced strains of rings have a limit; for if their expansion be such as to approach the rupturing point, it is plain that they are liable to burst from any fresh strain, however slight. But once these hoops are broken, the interior layers are no longer in a state to resist the pressures in the bore, so that such a gun might burst under a much less pressure than a gun not made with rings, and of the same thickness. But we may avoid this inconvenience by calculating the degree of tension of the rings with exactness; and thus we may construct a much stronger cannon than any non-hooped gun of the same dimensions.

Again, the useful effect of ringed structure does not depend on the rings being made of a metal of higher resisting power than cast iron; for if, on a cylindrical cast-iron gun, a second cylinder of cast iron could be forced under favourable conditions, this gun would become once and a half times as strong as an ordinary gun of the same dimensions, and exempt from interior strains.

We thus see how important a part internal strains play; but yet we have not considered the case of a single cylinder forced on to another cylinder. If a gun could be constructed of a great number of cylinders, each of which should compress the preceding one, the resistance would be enormously increased. This is precisely what happens when a cannon is made of a metal capable of undergoing great permanent elongation; for the interior rings, which always expand more than the outer rings under the pressure of gases in the bore, preserve likewise a greater permanent expansion when the pressure ceases to act. Thus, after the firing of the first round, the inner rings are compressed by the outer ones, and the gun assumes the same state as that of one composed of concentric rings forced one on the other.

Generally the resistance of cast iron is so insufficient that a gun formed of this material would be unable to resist the strains of discharge, if some special cause increasing the resistance did not exist. This cause is to be sought in the property possessed by this metal of undergoing permanent elongation. In fact, it is plain that if there be two cannons the metal of which differs in the property of undergoing permanent elongation, even though the resistances to tensile strain be the same, the metal of that one of the two which undergoes the greater permanent elongation will be the stronger; and that if the resistances to tensile strain also differ, the cannon the metal of which is the less resisting may offer a greater total of resistance than the other, provided that this less resisting metal be capable of taking greater permanent elongations. It is therefore a matter for regret that so important a factor should have been lost sight of in the American experiments.

But there is another factor, the influence of which is no less considerable, namely, the internal strains which arise from the cooling of the metal. In the ordinary way of casting guns the mass of liquid metal cools in concentric layers, beginning at the layer in contact with the mould; this layer continues to cool after it has become solid, and the others solidify successively in proportion as the heat disengages itself through the already solidified layers. The result is that each layer as it becomes solid attaches itself to an exterior and already cooled layer, and there produces the same internal strains of which we have already spoken.

To thoroughly understand the nature of these strains, let us suppose a series of very thin cylinders, diminishing in diameter successively, so as to be capable of entering one another with a certain amount of play; and let us imagine a cannon constructed as follows:—Suppose that into the first cylinder the second be introduced, after having so expanded it by heat as to have caused the play or clearance to cease to exist; and suppose that in this state the two cylinders be intimately united to one another so as to form but one. It is evident that the inner cylinder, in cooling, can only recover its original dimensions by straining the outer cylinder, that is to say, by compelling it to contract along with it; but the outer cylinder reacts in virtue of its elasticity, and thus the inner cylinder cannot contract completely, and its molecules will be in a state of permanent tension. Now, if into the second or inner cylinder a third be introduced under the same conditions as the second in relation to the first, and again a fourth, and so on, each of these cylinders on cooling will be in a state of permanent tension. But a cannon so constructed would plainly have much less resistance than another where these internal strains did not exist; for before the pressure in the bore would commence to act the inner rings would be already stretched, so that a comparatively small force would suffice to increase their dilatation up to the point which would produce rupture. In such a cannon the outer rings would not only not contribute to the total resistance, but they would have an injurious effect in increasing the dilatation of the inner rings; and it is conceivable that in certain cases rupture might ensue in the inner rings without the help of any pressure in the bore.

The preceding, as given by the American experimenters, is, in fact, a sort of rough and rather crude summary of the now well-known theory of "ringed structure" in ordnance, and of internal strains, due either to heating the interior of the gun, as in firing quickly hot shot, or by cooling first the exterior when the gun is cast.

It is but the usual practice with American writers that, as here, they ignore all that has been done by others before them. One might suppose this all original research who knew nothing of those who in Europe have originated and perfected the theory of ringed structure. There can be little doubt but that it was Mallet's researches upon the interior strains on guns heated by quick firing, published in June, 1854, which suggested the converse problem, and led to the now world-famed Rodman method of casting by cooling from the inside.

To resume. We see that there are two causes which may render a gun weak, although the metal may be of great tenacity; and that the properties of cast iron which produce this discrepancy are:—

1st, The capability of receiving but very slight permanent elongation under the action of a tensile force;

2nd, The considerable contraction which cast iron undergoes in cooling.

(To be continued.)

CASTING OF THE AMERICAN 20-INCH GUNS.

To the preceding article, On Some Points of Practice in Iron Founding, which refers entirely to the theory and practice of gun founding, the following account, derived from an American source, of the actual casting, by the Rodman method, of one of those monster 20-inch guns at Pittsburg, may form a very suitable sequel. These guns are probably the largest ever cast in iron. Three, if not four, of them have now been cast at the gun foundry at Fort Pitt, and the pouring of this, the third of the kind which has been made, and its subsequent cooling from the interior, with all the appliances at the disposal of the foundry, is said to have been a complete success. The metal was contained in three furnaces; one containing over 30 tons, the second and third 16½ tons each, or a total of 63 tons required for the casting. The metal was a mixture of Bloomfield (Juniata) iron of the first and second fusions.

The three furnaces containing this enormous mass of metal were lighted in the morning at half-past four o'clock, and the metal was ready for pouring soon after noon. Notwithstanding its enormous dimensions, the mould was as carefully prepared and as skilfully adjusted as that of a Parian vase. It had been prepared several weeks beforehand, and consisted of two longitudinal sections, each covered with an even layer of a mixture of charcoal-dust, clay, and molasses. These two parts had been several weeks in the stove, until the lining had become as hard as stone and perfectly dry. They were securely bound together with chains, before being placed in the pit by means of a powerful crane. A hollow core of rather less than 20 inches diameter, and prepared in the same manner as the mould, was then hung in its interior, and perfectly adjusted so as to form the bore.

At two minutes past noon the first and second furnaces were tapped, and the third at three minutes past noon. The metal was led from the furnaces to the mould along gutters, the longest of which was 60 feet. It was collected in a small well or reservoir before passing into the mould, and was led thence by other conduits to different points round the pit. The furnaces ceased running at twenty, twenty-three, and twenty-four minutes past noon, respectively. At the commencement of the operation the temperature inside the foundry was 27°·78 Centigrade, and 25° outside.

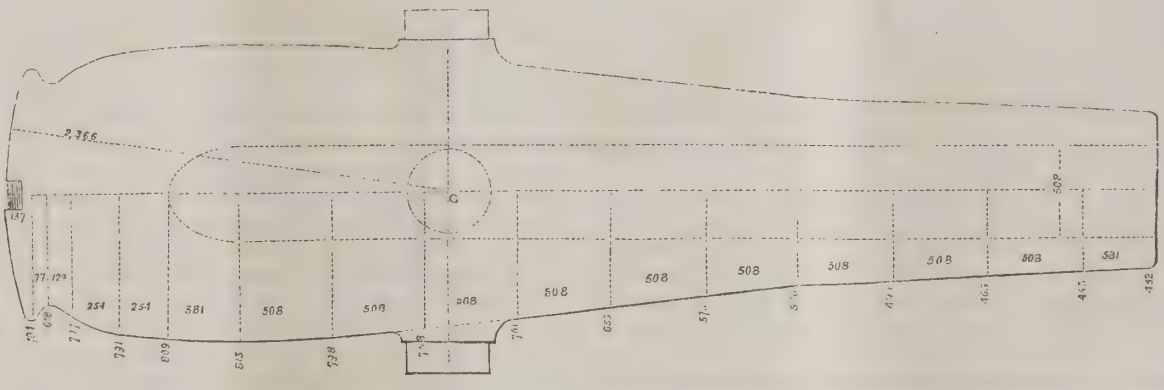
Immediately on the completion of the pouring the hydraulic apparatus began passing water through the core at the rate of 38 gallons a minute, so as to cool the inside of the gun more quickly than the outside. When the water commenced to run the temperature rose to 27°·22; when the core was filled it was at 37°·22. Ten minutes after it rose to 45°·56, and at the end of twenty minutes to 47°·78: it preserved this temperature up to the second morning, and then gradually fell to 36°·11. Eight minutes after beginning to pour, the gases began to be disengaged, and continued to burn up to two o'clock in the afternoon. This gas came from the paying of hemp yarn which the core had on under the loam. The combustion of this yarn loosened the core so as to allow of its being withdrawn from the piece. At 1.40 P.M. the fires were lighted at the bottom of the pit round the casting, and were kept alight for several days for the purpose of causing the outside to cool more gently than the inside of the gun.

On the morning next but one after the pouring, at 9.20, it was decided that the metal of the inside of the gun had hardened sufficiently to allow of the core being withdrawn. The supply cock was closed, and in a few instants the increasing temperature had caused every drop of water to disappear from the interior. At 10.45 the water was again suddenly turned on, and the core contracted rapidly, and it was then quickly and gently lifted out of the bore of the gun. The operation was continued by injecting a stream of cold water of the thickness of a straw into the interior of the bore. The first contact of the water with the burning metal produced an explosion like that of a discharge of artillery. This slender stream of water continued to run up for two days, when it was replaced by a current of cold air, which is urged through a pipe to the bottom of the bore by a powerful fan blast. This will be continued until the gun is perfectly cold.

This huge piece of artillery will take about twenty-five days to cool before it can be withdrawn from the mould. It will then be finished, and brought to the proof ground. The proof will consist of nine shotted rounds. The first three charges will be composed of 60 lbs. of mammoth powder, the three following charges of 80 lbs., and the last three of 100 lbs. The weight of the projectile is 1084 lbs. This monster gun is intended to arm the turret of the *Puritan*. Another gun of the same kind, which is now actually on the proof ground, is for the *Dunderberg*. These two engines, with another which is in the land service, are the only 20-inch guns which have ever been cast in iron.

The following are the principal dimensions of the finished piece:—

	Metres.	Ft.	In.
Total length,	5·029	16	0
Length of the bore,	3·733	12	3
Depth of the chamber,	0·254	0	10
Diameter of the breech-lump,	0·355	1	2
Exterior diameter at the breech,	1·625	5	6
Do. at the muzzle,	0·909	3	0
Length of the trunnion,	0·457	1	3
Radius of exterior curvature of the breech,	0·812	2	4
Thickness of the metal,	0·558	1	11
Weight of the finished piece,	40 tons.		



COIN AND COINING.

By JOSEPH NEWTON, Royal Mint.

(*Continued from page* 207.)

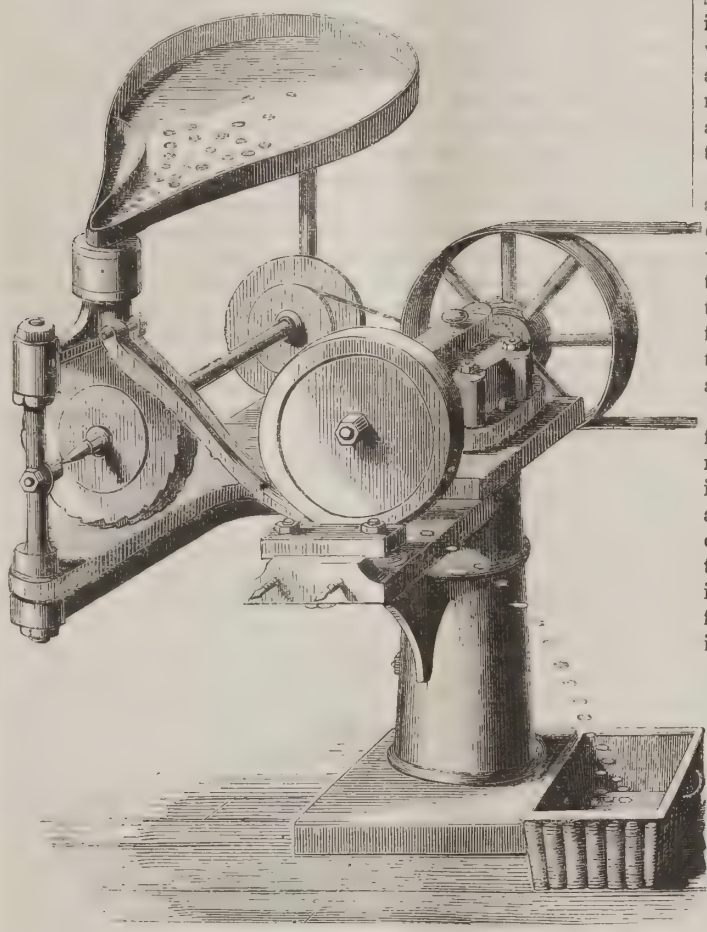
THE proportionate weight of blank pieces produced from a certain quantity of adjusted fillets is usually as eight to four; that is to say, eight-twelfths of the metal goes forward for coining, and four-twelfths is returned in the shape of scrap, or "scissel,"* as it is termed at the Mint, to the melting-house. With the scissel, however, we have for the present done. It is our mission to go forward with the blank sovereigns, of which the Mint cutting presses may be made to yield, if necessary—which it very seldom is—200,000 per day of ten hours. It has been said already that they are after careful weighing deposited in bags. These contain each 2804 pieces, or 720 ounces, and in such detachments the blanks are forwarded to the Marking room. The name of this place has the disadvantage of not conveying to the uninitiated the faintest notion of the operations performed within it. In fact, it is well calculated to impart a totally erroneous impression of them. At Goldsmiths' Hall certain "marks" denote the various degrees of fineness of the precious metals, but "marking" at the Mint has a totally different meaning.

In order to make the process understood, it may be well at once to say that "marking" means a compression of the edges of the circular

* From the French *Sciceser*, "to cut as with scissors," which is from the Latin word, *scindo*, "to cut"—as supposed.

planchets of metal, or the raising of a rim upon their peripheries. All are aware that finished coins are supplied with protecting edges, to save their surfaces from abrasion. Now, unless marking be resorted to at a preliminary stage in the operation, it will be manifest that when the finishing touch which gives the impressions comes to be administered, it must be a very heavy touch indeed. The inner surfaces would have to be depressed to such an extent as to leave the edges standing above them. This would in all probability cause the fracture of the steel dies which imprint the coins. In order to obviate the evil, "marking" is resorted to, and it is a very effectual proceeding. To make it more readily understood, an illustration of one of the most recent marking machines is here introduced.

It consists principally of a disc of hardened steel, which has an annular groove of $\frac{1}{16}$ of an inch in depth and $\frac{1}{8}$ inch in breadth, cut in its face near the outer circumference. The disc is securely keyed upon a spindle of the same material as itself, and running in gun-metal

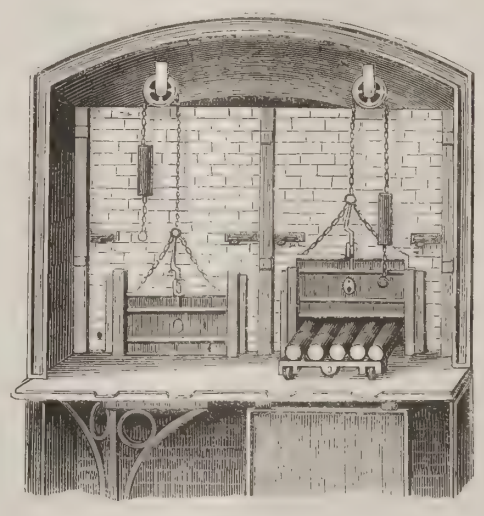


bearings. In front of the disc a steel cheek—adjustable as to distance by means of set-screws—is attached to the bed of the machine. On the face of the cheek a groove is also cut, and the groove forms a segment of the same circle as that which exists on the disc. Between these running and fixed grooves the blanks are marked or compressed. The extent of compression is regulated by the distance between the grooves, which again is governed by the denomination of blanks being operated upon. In order to feed the compressing apparatus with material to work upon, a copper pan, as seen in the drawing, or a bent tube, as is sometimes used, is placed above the machine. Into this receiver, after another weighing, the planchets of gold contained in one bag are deposited; and as the contents of all succeeding bags follow in the same course, it may be well to confine attention for the present to one bag only. Thus then, all is ready for action, and the marker causes the blanks, by a little manipulation, to drop through a tube at the base of the hopper, and below which is a feeding-wheel, on the circumference of which the column of blanks rests until the machine is started. The wheel has serrations on its edge of $\frac{1}{32}$ of an inch in depth, and $1\frac{1}{4}$ inch pitch. Once therefore it is set in motion, in the direction of the disc, each notch on the edge of the wheel carries forward one blank until it falls down by its own gravity through a slide, which conducts it exactly to the grooves of the compressing apparatus. By force of friction the running groove carries it forward, turning the blank round twice or thrice in the process, between itself and the dead groove, and then throws it into the basket, as represented above. On examining the blank it will now be found somewhat smaller in diameter than when put into the hopper, and thicker on its edge—in fact, it is "marked." It is, however, quite plain on its circumference, and not milled as the "Encyclopædia Britannica" asserts it to be at this stage. Milling is a subsequent process, which will have hereafter to be described.

As with one blank, so with the whole contents of the bag, and so with those of all succeeding bags, no matter what the denomination of coin. When in full operation the marking machine operates upon, and discharges into the catch-basket no less than 600 blanks per minute. They descend from the compressing grooves in what may almost be termed a stream, and which fact is not inaccurately delineated above. Occasionally the attendant tests the correctness of the work, by passing individual planchets through a steel gauge collar. The slightest variation, by wearing or vibration, in the distance between the live and dead grooves of the machine is thus discovered, and, of course, re-adjustments are then made. The four marking machines at the mint are driven from a light overhead shaft, by means of pulleys and straps, the power required being nominal.

When one bagfull of gold planchets have been marked, the pieces are collected and re-weighed. They are then divided into four portions of 180 ounces, or 701 pieces, deposited in small canvas bags,* afterwards neatly folded, and placed in wooden trays to facilitate removal to the next department, which is known as the Annealing room. In this place the planchets must be submitted successively to the action of fire and water, and acid baths, before they are in fit condition to receive that stamp of royalty which warrants their passing from the Mint gates, and into the hands and pockets of the Queen's lieges.

The fine rolling and drawing to which, it will be remembered, the fillets of gold were submitted before reaching the cutting presses have rendered the blanks punched from them hard and obdurate, whereas it is necessary that they should be made soft and impressionable. Fire and water, as with sterner metals, are the agents for effecting these changes of disposition, and the annealing room, as its name implies, is the scene of transformation. It is furnished with three pairs of annealing ovens on the reverberatory principle, and heated by six Juckes' furnaces. An illustration of one pair will suffice to convey a correct idea of the whole series.



It exhibits a front elevation of the ovens and brickwork, the furnaces being at the rear. It will be seen that one oven is shown with its sliding door raised by aid of a counterpoise weight and chain, whilst the other is closed. A table of iron in front forms a resting-place for the miniature carriage of iron, upon which are placed the charged pans or tubes of gold, silver, or bronze—for all have to be submitted to the

* These lesser bags, when charged with gold, are known at the Mint as "journeys." The term is no doubt derived from the old Norman word *journée*, and which may have once meant a day's work, and still means a determinate task of work.

same process—before being backed into the ovens. The annealing room is also furnished with copper-covered tables, fluted trays, blocks and falls, and other accessories of more or less importance.

In accordance with the plan just named we shall confine our attention to the one bag, or four journeys of golden blanks, which have arrived from the marking machine. The pieces are gently shot into fluted wooden trays, and the workmen, by dexterously shaking the latter, cause the blanks to range themselves on edge, and in *rouleaux* along the flutings. This facilitates their removal by hand into the annealing pan, which is a cast-iron box of just sufficient capacity to hold easily the 2804 blanks, in *rouleaux*, along its base. The next movement is to inclose them in their prison-house, and to insure their perfect seclusion from atmospheric influences while in the oven. A stout cover of plate-iron, fitting into the annealing pan, and resting on ledges which just keep it from contact with the gold, is placed over the rich freight. The edges of the plate are luted with fireclay, and then, to "make assurance doubly sure," a second plate is placed above the first and also luted. These precautions are for the purpose of preventing oxidation, volatilization, and discoloration of the metal whilst in the oven.

The loaded pan is now deposited on the carriage and pushed into the recesses of the oven, the door being closed upon the whole. Some thirty or forty minutes' baking is generally sufficient for cooking the dish, which is then withdrawn while at a cherry-red heat, and allowed to cool gradually.* When the temperature of the pan is considered low enough, the covers are removed and the contents discharged into a copper tray. By main strength a workman conveys them next to the blanching-room, and quenches them in cold water. This completes the softening process, and in a colander they are transferred to a cast-iron and lead-lined copper (if it be not a misnomer so to call the vessel) of nearly boiling dilute sulphuric acid. Here the blanks remain for the space of two or three minutes, being vigorously stirred about the while, and they are then removed. The effect of the hot and strong bath on the faces of the bathers is seen at once. They are brightly yellow, instead of dusky brown. The surface of oxide of copper has gone from them, and is succeeded by one of fine gold.

In the case of silver the change is yet more startling. It contains a larger percentage of alloy, and on leaving the ovens the blanks are as black as those which fall from a sheet-iron washer cutting-machine in an engineer's shop. After the acid bath they come out as white as snow, and *are*, technically, "frosted." Bronze blanks are allowed to remain in cold dilute sulphuric acid for many hours, but *their* visages are not so much improved by the dipping.

The golden batch, of which we have for the moment lost sight, are now being washed free of all traces of acid and sulphate of copper, by means of a stream of cold water, which is made to impinge forcibly upon them. After this they have to be dried, and this is done over a flat stove, upon which is placed a quantity of beech-wood sawdust, and by aid of sieves and friction. Finally, they are placed in a muffle perforated with small holes, and agitated, so as to free them from dust, in a hot air bath. On examination now, the candidates for sovereign honours will not be found unworthy their destiny. They are free from all corruption, capable of receiving and retaining good impressions, able to do the state great service, and are altogether of sterling character.

Gold blanks lose slightly in weight by annealing and blanching, but it is only a portion of the alloy which disappears, and this has been previously provided for in the melting house. Silver blanks diminish in weight to a greater extent by the same processes, but a similar remark applies to them. Of both it may be asserted, that after their baths they are all precisely of the true legal standard † of Great Britain. Of course batch after batch follow from the cutting-room to be treated as described, the identity of each bag of metal being preserved throughout, and all working losses being noted in hundredths of an ounce upon each accompanying and numbered work ticket.

PARIS EXHIBITION.

NOTICES OF SOME SPECIALLY INTERESTING OBJECTS, &c.

PHOTOGRAPHY.

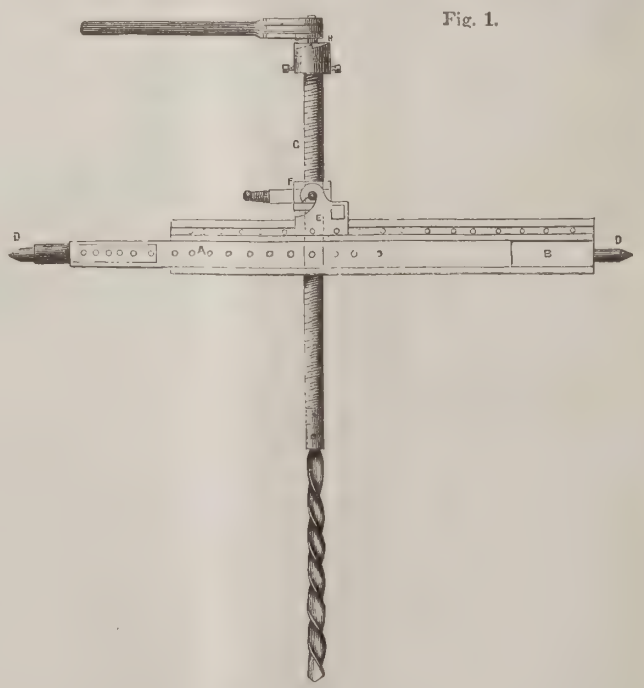
In the pages of this Journal it was several months ago suggested that the combined arts of Photography and of Glass Painting might be made subservient to the production of the most durable of all portraits, as against the tooth of time, though of course fragile and liable to destruction by violence or accident. Whether our suggestion may have given rise to the thought becoming an accomplished fact, or whether the thought independently occurred to others as well as to the writer of the article in this Journal referred to, the thing itself has now been actually done. In the annex in which a good deal of stained and painted French glass, principally from Metz, is exhibited, are to be seen not only photographs in which the light and shade of landscapes and interiors, &c., are "burnt in" to the glass, but portraits, in which the outlines and lights and shades of the face and figures produced by the photographer have afterwards been coloured and the whole burnt in; the effect of these is excellent. In the case of the landscapes and interiors, nothing is wanting to the great beauty of the effects; and with suitable choice of subjects for the airy, weird-like character of the lights and shades thus rendered, this photography on glass may be made one of the most beautiful auxiliaries to domestic window decoration. A few surrounding bits or bands of well chosen and harmonized coloured glass, with the remainder of the window filled in with these translucent glass monochrome photographs, would be an immense advance upon the glaring, hideously discordant blazes of vulgar coloured patches, which at present constitute "the style" of the "stained-glass" lobby and other windows of all that have such a luxury at all, even of our first-class London houses.

Photography has been largely employed for the decoration of porcelain and coarser pottery, and of some japanned goods abroad, and in some instances the photographic impress has been "burnt in," and rendered probably quite imperishable; in others the plate of glass or of china upon which the impression has been deposited has been involved in glass, through which it is seen, and has thus been rendered inaccessible to all agencies but that of light, or some possible chemical reaction of the involving glass itself. This last method has been known in England for a good while past.

LISBET AND JACQUET'S PERFORATER.

This perforator is somewhat similar in construction to the machines ordinarily employed for drilling holes in metals, and is worked by hand,

Fig. 1.



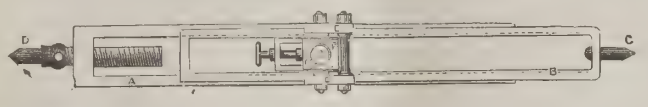
one man being sufficient for the purpose. It consists of a frame formed of two parts, A and B, the one capable of sliding in the other, so as to admit of lengthening the instrument to suit the height of the gallery where it is required to be worked. The lower part of the frame carries a steel centre, D, and the top part is also provided with a screw terminating in another centre, D. The two parts of the frame are formed of

* Silver is treated similarly, except that the pans are open, and bronze is placed in iron cylinders, with a layer of charcoal over the blanks.

† See Note, No. xxviii., page 104.

plates of iron or of cast steel cast flat, about $0^m{\cdot}120$ in width, and bent at right angles at their extremity, so as to form a rectangular frame. Between these plates a guide, E, is disposed, which may be adjusted and fixed at any required height, by means of a pin passing through corresponding holes formed in the guide and in the frame. The guide, E, carries a nut, F, in which works the hollow screw, G; the interior of this screw is traversed by a rod, to one end of which the boring tool is fixed, and the other end has a square head, H, to receive the lever, K. The screw and nut with the drill carrier and lever are capable of an oscillating motion round two trunnions with which the guide is provided, so as to adjust the tool to the required inclination of the hole to be bored in a vertical plane; the screw, L, maintaining the same secure at

Fig. 2.

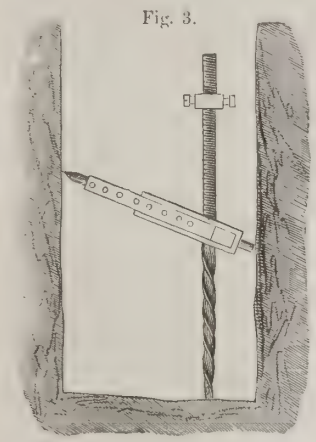


the position desired. The whole of the apparatus may also be turned horizontally round the centres C and D, which fix the frame to the roof and ground of the gallery; and the guide itself being movable on the frame, it is evident that by this machine the holes may be bored at any required inclination and to any desired height. The lever, K, is used to impart to the tool the requisite rotatory motion, and by means of a catch attached to the lever, K, which enters notches in the head of the screw, G, the advancing motion of the boring tool is effected at the same time. The tools used with this apparatus vary from $0^m{\cdot}025$ to $0^m{\cdot}038$ in diameter.

Another arrangement consists in substituting for the rod working in a hollow screw, a bar provided with a rack, in which works a pinion attached to the guide, which transmits motion to the rack, and thence to the tool-carrier.

It will be observed that the machine is exceedingly simple in construction and operation; it is capable of working in hard rocks, quartz excepted. The advantages obtained by its use over the system of perforating with the punch, have been ascertained by trials made in Belgium and France, the particulars of which we cannot here give in detail, but shall confine ourselves to indicating the mean results obtained by various engineers who have experimented with the apparatus.

Fig. 3.



The following results were obtained in July, 1864, at the Villars trench (Anzin) in two days' work, the tool being operated by two workmen. In 18 hours 25 minutes, holes were bored equal to 19^m 64 in length. The time occupied in setting the perforator was 2 hours $21\frac{1}{2}$ minutes. The total length of time employed in boring, including the setting of the tool, was 7 hours 14 minutes, with a cessation of 11 hours 11 minutes.

The gallery, which was situated in a hardish pyritic rock, was $1^m{\cdot}90$ in height, by 1^m 60 wide, and in the two days' working a length of $2^m{\cdot}10$ was bored. On taking into consideration the time employed in setting the apparatus, it will be seen that the mean length is $19^m{\cdot}64$ in 7 hours 14 minutes, or $0^m{\cdot}045$ per minute; and if we set aside the time employed in setting, we obtain as the actual working of the drill (not the duty done) $19^m{\cdot}64$ in 7 hours 14 minutes — 2 hours $2\frac{1}{2}$ minutes = 4 hours $52\frac{1}{2}$ minutes, say $0^m{\cdot}067$ per minute. In order to estimate the value of this result it would be desirable to know the diameter of the holes bored, and the exact nature of the rock operated upon.

Experiments were made in 1864 at Seraing (coal-mines of *La Société de l'Espérance*), in a bed of grit-stone of average hardness; two men bored with the perforator a hole $0^m{\cdot}04$ in diameter, and $0^m{\cdot}565$ long, at an inclination of 8° to the top of the gallery, in 33 minutes, including the time requisite for putting the machine in its place and changing the bits, or, say, a mean length of $0^m{\cdot}017$ per minute.

It has also been proved by other trials made in various Belgian mines, that a considerable saving in the cost of boring galleries is effected by the use of this machine. These results also appear to be confirmed by experiments which took place at Creusot in 1864.

It will be perceived that this apparatus is not intended to be driven by motive power, consequently the advantages resulting from its use are not due to the rapidity or power with which it works, as is the case in mechanical perforators, but to dispensing with the ordinary guiding operations of the workmen in continually adjusting the inclination of the tool; for in this apparatus, once the tool is set to the required angle, nothing more is required than simply to turn the lever, which necessitates not so much constant attention on the part of the workmen, as activity and energy.

SAMAIN'S PRESSES.

M. Samain, engineer of Blois, exhibits two compressing apparatuses, one of which, the jointed lever press, obtained the only gold medal of that section at the national competition of 1860, and a platina medal from *La Société d'Encouragement*; and the other, the antifrictional screw press, on an entirely new system.

The jointed lever press is composed of four double connecting rods or links, *a–b*, *c–d*, *e–f*, *g–h* (see fig. 1), jointed as shown, the ends,

Fig. 1.

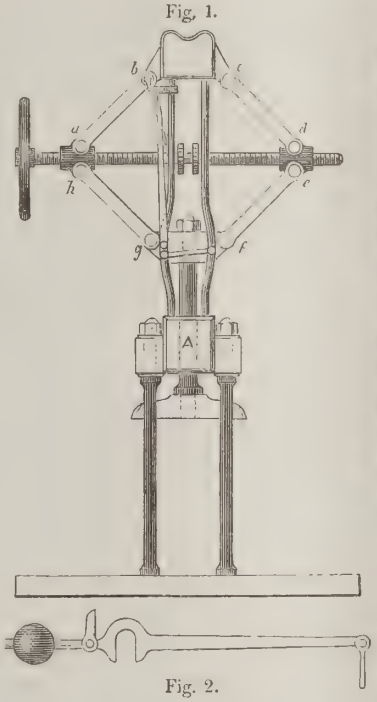
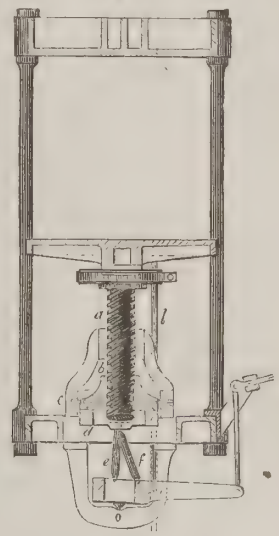


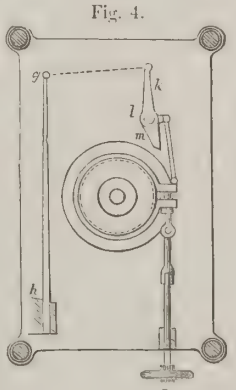
Fig. 2.

Fig. 3.



a–h and *d–e*, of which are connected to nuts in which a right and left hand screw works. A beam at the top, *b–c*, is secured by four slightly curved rods to another beam, A, which, by means of uprights, is itself firmly secured to the foundation plate, and may be made sufficiently long for the upright to be placed outside the material to be compressed: *f–g* shows a beam connected with the rod of the compressing plate. At the middle of the screw there are two ratchet wheels, between which a lever (fig. 2), loose on the axis of the screw, moves, and it is provided with a pall, which serves to transmit its motion to the screw. By turning the screw in a suitable direction the horizontal diagonal formed by the rods or links is shortened, and the vertical diagonal elongated, which, as the joints of the links at the top are stationary, causes a downward motion of the compressing plate; but it should be observed that while the nuts approach each other at a uniform speed, the speed at which the compressing plate descends constantly diminishes in proportion to the vertical elongation, whilst, on the other hand, the resistance that the compressed material offers increases in proportion as its volume diminishes, consequently the *force* and *distance* vary in inverse proportion the one to the other, the resisting work per unit of time

Fig. 4.



increasing but little: the very reverse of the ordinary presses, in which the rate of compression is directly proportional to the speed of the power, so that with a constant, or nearly constant, motive power it is possible to attain in a given time to a much more effective pressure than with ordinary presses.

In the ordinary presses, in addition to the friction of the screw in the nut, which we will assume to be the same in both cases (although the lubrication is more effectual with a horizontal than a vertical screw, and the pressure on the nuts in this press is always less than the resisting pressure, whilst in the ordinary presses the pressures are equal), there is the greater friction of the nut on its seat, since the mean diameter of the circumference in contact is at least half as much again as the mean diameter of the thread, and the lubrication of this part is even more neglected than that of the screw. In order to form some idea of this resistance, suppose a screw, in which the pitch is $\frac{1}{15}$ of the mean circumference of contact of the screw and nut, it will be about $\frac{1}{25}$ of the mean circumference of contact of the nut on its seat; and taking the co-efficient of friction at $\frac{1}{10}$, the proportion of work lost by friction of the nut on its seat to the useful work produced will be

$$\frac{\cdot 1\ \mathrm{F} \times 25}{\mathrm{F} \times 1} = 2{\cdot}5$$

By thus assuming a mean co-efficient of friction and a proportion of the pitch to the circumference, which is but little exceeded in screw presses, we see that the power lost in friction between the nut and its seat, and economized by M. Samain, is at least two and a half times the useful work produced, so that the useful effect of this machine is nearly three times that of the ordinary screw presses. The screw engaging in the matter to be compressed (as is the case in some screw presses) is also a great source of friction, which is entirely obviated by Samain's arrangement.

M. Samain has also added to it a dynamometer and a species of automatic brake apparatus, the object being to utilize the tendency to straighten themselves of the four slightly-curved rods which unite the beam, *b–c*, to the beam, A, by placing an axis on one of the rods, around which a hand oscillates, the same being connected at its lower end to a connecting link, the other end of which is centred on the curved rod, in the opposite direction to that which carries the hand; the straightening of these two rods will cause the hand to describe an arc on a graduated scale, and the motion of the hand is utilized to impart a motion to a species of pall, which abuts against and holds fast the driving lever when the pressure is at the maximum that the apparatus is designed for. With a few slight modifications the machine may be worked by mechanical power.

With regard to the antifrictional screw press, shown in section and plan at figs. 3 and 4, in external appearance it somewhat resembles a vertical hydraulic press, but the compressing plate is carried by a screw instead of by a piston: the screw is of such a pitch that the nut, if left to itself, will descend alone when the screw is vertical. On this screw there are two nuts, *a* and *b*, resting respectively on discs, *c* and *d*, only susceptible of an alternate upward or downward motion; and under each disc there are two catches, *e e′* and *f f′*, placed on the same diameter, and resting on a lever oscillating on pivots, *o* and *o′*, and inclined two at the right and two at the left of the axis of the screw. The result of this is, that when the lever is depressed the two catches, *e e′*, rise and elevate the disc, *c*, the nut, *a*, and finally the screw; whilst the catches, *f f′*, descend, the disc, *d*, descends with them, and the nut, *b*, being no longer supported, descends of itself until it comes in contact with its seat, and the lever being raised again, the nut, *b*, is elevated in its turn, carrying the screw in its upward motion, whilst the nut, *a*, descends. This constitutes a double silent catch, with a variable stroke of as small a range as desired, and yet capable of much greater efforts than can be produced with a rack catch. The arrangement possesses the advantage, moreover, of entirely obviating the friction of the nut on the screw and on its seat.

We have pointed out the great advantage derived by obviating the friction of the nut on its seat, but its friction on the screw is also of considerable importance, for with a screw of a pitch equal to $\frac{1}{15}$ of the mean circumference of contact, the proportion of the friction of the nut on the screw will be

$$\frac{\cdot 1\ \mathrm{F} \times 15}{\mathrm{F} \times 1} = 1{\cdot}5;$$

therefore, in an ordinary screw press, the loss from friction is $1{\cdot}5 + 2{\cdot}5 = 4{\cdot}00$ times the work performed; the useful effect then is only $\frac{1}{1+4{\cdot}00} = 0{\cdot}20$ at the maximum, without taking into consideration the loss from friction in the other parts; whilst in this arrangement nearly all that loss is prevented, there being only the friction on the pivots, which is so small that it may be omitted from the calculation, so that the respective proportions of useful effect in this apparatus and the ordinary apparatus are as 0·90 to 0·20.

The self-acting brake apparatus is also worthy of observation. The screw is not keyed on to the compressing plate, but carries a brake pulley, the collar of which is united to a spring, *g h* (fig. 5), fixed at *h*. On this plate the connection between the brake collar and the spring is effected by a bell crank motion, *k*, turning round a vertical rod, *l*, which is provided with a slot, and carries a piece, *m*, provided with a key, which engages in the slot of the rod, sufficient play being allowed to admit of the vertical rod being elevated or depressed with the compressing plate, without the piece, *m*, following its motion. It will, therefore, always remain at the same height corresponding to the lower part of the external nut, *a*. When the brake collar is locked, the spring prevents the screw from turning under the influence of the torsion produced by the inclination of the screw thread; the result of which is, that when the pressure attains to a certain limit the horizontal torsional strain which is transmitted to the brake is capable of carrying away the spring, and with it the piece, *m*, which, coming in contact with and pressing upon the external nut, prevents it from turning round, and consequently descending, and the alternate motion of the nuts being stopped, the screw can no longer be elevated, since it will bear always upon the same nut.

This press is claimed to be preferable to the hydraulic press wherever intermittent work is required, and when mechanics are not employed, as there are no parts liable to get out of order, whilst in all other cases they are said to be at least equal to hydraulic presses.

GANNERON'S MACHINES FOR THE DECORTICATION AND PREPARATION OF RICE.

M. Ganneron's decorticating machine consists of a pair of fluted cylinders supported by a frame, with a hopper disposed above the cylinders, and of an exhaust tube, through which the husks are discharged. After being thrashed the grain is introduced into the hopper, whence it passes between the two cylinders, where it is decorticated; motion being transmitted to the cylinders by means of a wheel, which is turned by manual labour, at the rate of about thirty-five or forty revolutions per minute. The attendant can ascertain at any time through an aperture made in the cover of the frame, whether the action on the grain is uniform, or the cylinders are choked up. At the commencement of the operation the rice must be particularly watched to see if it be either broken or imperfectly decorticated; if the former, then the cylinders are too close, and require to be adjusted further apart, which may be effected by the aid of two hand wheels; but if the grain passes through only partially deprived of its husk, then the cylinders should be brought closer together by turning the regulating wheels in the opposite direction. When once the most suitable gauge for the cylinders has been ascertained, it is maintained by connecting the two wheels by means of a strap. The rice, after being decorticated, passes through a conduit provided for that purpose into bags, and its husk is projected through an opposite aperture. Should a little husk pass through with the rice, that may be obviated either by augmenting the velocity at which the machine works, or by adjusting the exhaust tube for the husks by the motion of a screw, so as to enlarge the aperture.

After the rice has been decorticated it still remains enveloped in a species of pellicle or pericarp, to liberate it from which it is requisite to submit it to another operation. For this purpose a machine is employed, consisting of a hollow horizontal cylinder, into which the rice is introduced. To this cylinder is imparted a rotatory motion, whilst its axis, which is provided with a number of pallets, so as to agitate the rice, turns in the opposite direction. The machine is turned by two men for the space of fifteen or twenty minutes, according to the description of rice to be operated upon; at the end of which time it is taken out in a perfectly white and refined state.

Messrs. Ganneron & Co. have also machines for sifting the rice according to quality, the various kinds passing through into different trays provided for their reception.

THE MANUFACTURE OF IRON AND STEEL IN SWEDEN.*

SWEDEN is about 170,289 square miles in extent, and upwards of one-tenth of it is composed of lakes. Its population, according to the census of 1865, amounted to 4,114,141 souls. The southern provinces are the most populous; but they vary greatly in this respect, so much so that whilst one has 6950 persons to each 38½ square miles, another has but 74. In the northern provinces the population is chiefly scattered along the sea-coast, and on the banks of rivers and lakes bordering the sea.

In 1865 there were 524 mines open throughout the country, but very unequally distributed amongst the provinces. More than 5000 workmen were employed, and the produce amounted to about 490,000 tons of ore. In addition, some 20,000 tons of ore were extracted from the marshes of some of the provinces.

The situation of the mines will not always admit of the use of water power for the drainage of the water and extraction of the ore, although shafts have been erected in some localities for the transmission of the power over great distances, even as far as half a league. It has been necessary, therefore, to have frequent recourse to steam-engines, of which there are forty-one in use at the present time.

As regards the blast furnaces and ironworks, the circumstances which determine their site are the existence of waterfalls of sufficient power, large forests, and available means of transport. The motive power for a blast furnace is ordinarily about 15 horse-power (nominal), including the blast engine and the grooved cylinder machine for crushing the roasted ore; but the latter machine is beginning to be superseded by the recently invented American machines used for preparing road metal. It is calculated that 220½ lbs. of cast iron require 198½ lbs. of charcoal, and that this quantity of charcoal is obtained from a surface of soil equal to about 5972 square yards.

The motive power for an ironworks may be estimated at about 8 nominal horse-power applied to the drawing iron into bars, and 5 horse-power for the blast engine, for an annual produce of 185 tons. If charcoal alone is employed, 220½ lbs. of bar iron will require at least 264½ lbs. of charcoal; but as gas-reheating furnaces are often employed, and which may be fed with wood, turf, coal, and even green sawdust (adopting a new invention which has been found perfectly successful), the proportion of fuel necessary is reduced to a minimum. It is, however, indispensable to the keeping a gas furnace in constant operation, that the produce be not less than about 600 tons per annum, for which 50 horse-power would be required to drive three hammers and a blast engine.

By the use of rolling mills, of which there are about twenty in the country, yielding respectively an annual produce of from 1200 to 2000 tons, or even more, a considerable saving in motive power, and especially in fuel, is effected. We cannot, however, estimate the consumption at less than 220½ lbs. of charcoal per 220½ lbs. of bar iron.

That quality of iron which is known to some metallurgists as *body* is obtained by selecting ores which contain the least possible quantity of phosphorus; and that other quality denominated *soundness* is believed to result from the presence of manganese.

With regard to wages, the ordinary workmen receive from 1*s.* 3*d.* to 2*s.* 1*d.* per day; whilst carters, finding a horse and cart, receive from 3*s.* 4*d.* to 5*s.* 10*d.* a day.

In the year 1865 there were 219 blast furnaces in Sweden, which employed 3583 men, and produced upwards of 226,000 tons of iron. In the same year the forges had 906 fires, where 5400 workmen were employed in the production of about 148,000 tons of refined and bar iron.

The ores (except bog ores) are roasted in vertical furnaces, heated by a portion of the gas proceeding from the blast furnaces themselves. The furnace most in use is that of Mr. G. Westman, which was first adopted at the Dannemora Works. The temperature therein is raised sufficiently high to render the ore perfectly soft, and expel the sulphurous acid proceeding from the oxidation of a portion of the sulphur liberated by the distillation at a lower temperature of the pyrites mixed with the ore. A portion of the sulphur is, moreover, oxidized by the oxygen of the ore. It has been found that the roasting of the ores at a high temperature facilitates the operations of the blast furnace.

In the production of pig iron it is thought desirable to attend to the following rules:—1st, the oxygen of the silica and alumina together should be double that of the bases; 2nd, there should be as small a quantity as possible of phosphorus and sulphur; 3rd, a sensible proportion of manganese should be present. But it may be remarked that manganese is often absent when the iron produced exhibits no symptoms of inferiority.

One charge of the blast furnace consists of a volume of charcoal of from 35 to 45½ cubic feet, to which are usually added from 8 cwt. to 11 cwt. of ore and flux placed on the fuel. The blast employed is air heated to about 392° Fahr. However, in the Dannemora blast furnaces cold air, or air heated to a temperature not exceeding 158° Fahr., is used for the purpose, in which case the charge of the ore does not exceed 9 cwt. for each 412 lbs. of charcoal. The charcoal must be carefully selected both in respect to size and quality, in order to effect the regular working of the furnace. It is also necessary that the ores be placed regularly on the charge of charcoal, and arranged in a thicker layer near the cap than in the middle, where it should be very thin. This last arrangement admits of using the maximum charge of ore. It has been found that the quantity of charcoal is ruled by the quantity of ore, whatever be the richness of the latter, at least between the limits of 45 per cent. and 20 per cent. in cast iron; providing that the other arrangements of the blast furnace are the same. The richest ores employed contain about 58 per cent. of cast iron, whilst the poorest contain 19 per cent.

When iron for casting purposes is required, the charge is so arranged as to yield very silicious cinders, which cool slowly. With such cinders the blast furnace yields gray cast iron, at least if the quantity of manganese present is very small; this iron may be employed directly for moulding, providing that the charge of ore be as great as possible without interfering with the working of the blast furnace. If it is required for the manufacture of guns, a charge is selected which contains a little sulphur, so that the iron may contain about ·09 per cent., which will render it less graphitic, and consequently stronger.

Among the various specimens of cast iron in the French Exhibition there were two which somewhat resembled in appearance white, coarsely crystallized iron, or *spiegeleisen*. One was the Nissafors iron, produced from the Taberg ore (Jönköping), which contains a noticeable quantity of manganese, and in addition 10 per cent. of titanic acid, the cinder of which was of a very basic character. The other was the iron of the Olsboda Works, from a charge to which a certain quantity of manganese ore had been added. The Kihlafors iron, which is made with cinders rich in manganese, has not the same appearance, because the blast furnace is charged with as much ore as it will contain without inconvenience; and it is well known that *spiegeleisen* requires to be somewhat lightly charged. Consequently the refining of this latter kind of iron is attended with more difficulty than the other, on account of the larger quantity of carbon and manganese that it contains. Iron intended to be treated by the Bessemer process should always be produced by a hot process, that is, with less ore than the blast furnace can carry, and with fluid or basic cinders. When there is sufficient manganese the iron presents the appearance of the *spiegeleisen*, provided it is allowed to cool slowly, otherwise it becomes more or less gray. That depends on the iron from the hot process combining with more silica, which retards the refining in the Bessemer converter, and admits of more attention being given to the process. Consequently when it is required to refine cast iron with a low furnace, and the operator is not thoroughly up to his work, or if the iron contain an excess of phosphorus or sulphur, it is better to produce a gray cast iron with the hot process. By this means a greater quantity of silica will be reduced, and an improved quality of iron obtained by prolonging the refining process.

In the manufacture of raw or natural steel, which is also carried on, though in insignificant proportions, in Graninge (Wester Norland), the metal is produced at so high a temperature that the blast furnace cannot continue at work with its small charge more than a few days at a time, on account of the infusible matters which gradually accumulate in the crucible.

Iron is refined either with a low fire or in a puddling furnace, or instead thereof by the Bessemer process. We may also mention the method of Uchatius, in which granulated iron is melted in crucibles with iron ore and a little charcoal; and also another method in which cast steel mixed with wrought iron is melted in crucibles. The former method is employed at Wiksmanshyttan with the rich ore of Bipsberg, and the latter is in use at Kihlafors with some excellent Hammarin ores.

The refining process with the low fire is effected by four different

* This article is the substance of a pamphlet by Mr. L. Rinman, the metallurgist, of Sweden.

methods. In the works which obtain their ore from Dannemora the Walloon method is adopted. Another method is that known as the Franche-Comté method, which was inefficiently carried out until 1853, at which period Mr. W. Didron began to improve it, and to show that it was possible to obtain good iron economically from its use. The third is the Lancashire method,* which is now almost always combined with the use of separate furnaces for reheating. This has been adopted at many works for the last twenty years, more especially those the annual production of which is not less than 850 tons; whilst a few works in which the annual produce does not exceed 200 or 400 tons, employ low fires for the reheating of the blooms and drawing them out in iron bars. The low refining fires of the Franche-Comté and the Lancashire systems are precisely similar in construction; but in the former system the refining fire is used at the same time for the "drawing" process, whilst in the latter there is a separate fire or gas furnace for the reheating purposes. There is yet another method of refining, invented by Mr. Rettig, of Kihlafors, which somewhat resembles the Walloon and Lancashire systems, in that the refining of the cast metal and the drawing of the blooms into bars is effected in different furnaces, instead of in the same as is the case with the German and Franche-Comté systems. It differs, however, from the Walloon and Lancashire methods in several particulars; for instance, larger masses may be treated by it, and the refining process carried to greater perfection; but it involves an increased consumption of fuel. An excellent iron for gun barrels, and steel of superior quality, are obtained by this method.

Charcoal is the fuel used with all these methods, which are all capable, if properly carried out, of yielding good iron. The Dannemora irons have usually a fine but irregular grain, which is due to the intermixture of hard and soft parts. This iron is invariably superior to others in ductility, tenacity, and strength. One remarkable peculiarity in this iron is, that in the fire it acts like iron of the softest description, and becomes full of stripes even when it presents the hardest appearance, and since it is always converted into cemented steel, which is then cast, the inequalities entirely disappear in the latter product.

The iron obtained by the German method is often very hard and irregular, but many consumers use it for tools requiring great durability. The iron produced by the Franche-Comté method is ordinarily very regular, and possesses, moreover, a degree of hardness in which the Lancashire iron is usually deficient.

The iron produced by the "Lancashire" method is commonly the most regular, which result is due to the fact that the drawing out of the blooms and the refining operation are effected by different persons, and it is to the interest of the refiner not to use inferior iron.

It is the reheating furnaces which exercise the most efficient control over the operation of refining. The blooms which are wanting in homogeneity, by reason of the men neglecting to work all the pieces in the same manner and with sufficient care, are broken when they come hot under the hammer, and throw off fragments along with blue sparks. Such blooms are then either rejected, in order to be submitted to a further refining process, or they are drawn out at a lower temperature for use in the works.

Of late years, two blast pipes have been tried in the "Lancashire" furnaces, one placed in front of the other, by which arrangement the production has been increased, and a saving of fuel effected; it is believed also that the homogeneity of the iron is thereby augmented.

The majority of the Franche-Comté furnaces are also furnished with two blast pipes. One of them is employed for the reheating process, on which account it is provided with a larger orifice than the other, in which the more compressed jet of air melts the refined fragments into a single piece of unwrought iron. The drawing blast pipe is placed above the fusion blast pipe, so that the former may be removed when it is required to use the latter, which is plugged during the drawing operation.

As to the iron required for edge-tools, it is desirable to obtain it of a fine grain, but full of stripes. The steely iron intended for cemented and rolled steel for springs is produced by the refining of the cast metal in soft or coarse grained metal—an easier operation, and one that gives more uniform iron.

Puddling is established at Motala, where the fuel used is pit coal, and where bars of various sections, sheet iron, and all kinds of machinery are produced. The annual production amounts to 2100 tons. Puddling with wood dried in the open air is also carried on at Nyby (C. Zethelius) for sheet iron, "fer profilé," &c., with an annual production of 400 tons; at Surahammar (W. Zethelius) for sheet iron, "fer profilé," tyres, &c., the production attaining to 1500 tons. At Nyköping, also, puddling is carried on with pit coal for the same manufactures as at Motala.

All these works are provided with rolling mills. The other Swedish rolling mills work up blooms, like those of Finspong and Lesjöfors, on the Lancashire system. Among these we may mention the following:—Hornefors (Westerbotten province) about 1000 tons; Axmar (Gefleborg) 1200 tons; Skebo (Stockholm) 340 tons of sheet iron; Furudal (Stora Kopparberg) 650 tons, partly for chains; Kloster (Stora Kopparberg) 1000 tons, chiefly sheet iron; Lindesnas (Stora Kopparberg) 1400 tons; Smedjebacken (Stora Kopparberg) 4200 tons;* Fagersta (Westeras) 1000 tons; Hallstahammar (Westeras), Bessemer plates and various descriptions of iron, 450 tons; Kohlsva (Westeras) 1500 tons; Bofors (Orebro) 1200 tons; Degerfors (Orebro) 850 tons; Gryt (Orebro) 1700 tons, one-half of which produce is steel; Hellefors (Orebro), large plates, &c., 2810 tons; Laxa (Orebro) 850 tons; Skyllberg (Orebro) 800 tons; Gefsbacka (Carlstad) 1280 tons; Munkfors (Carlstad), belonging to the Uddeholm Company, use a rolling mill for cemented steel, and iron of small dimensions, of which they produce about 900 tons, the entire production being 4300 tons; Skepsta (Nyköping), chiefly cemented steel, 350 tons; Boxholm (Ostergötland) 640 tons.

The Lesjöfors Works also sell cast iron (about 1020 tons), bar iron, ingots for wire drawing, wire rope, &c., amounting in all to 1360 tons. The Finspong Works, noted for its excellent gun barrels, produces about 5000 tons of iron in bars and shingled lumps, from the Upsala and Nora ores. The produce of the Gunnebo Works, which amounts to 700 tons, is converted into screws, rivets, nails, &c.

The works which have adopted the Lancashire method with reheating gas furnaces are numerous, and at the present time form the majority. All the rolling mills are, of course, provided with reheating furnaces, and these are almost without exception gas furnaces. Although for the most part these are constructed so that the gas proceeding from the combustion of an excess of fuel may pass through the incandescent charcoal, that is, from the top to the bottom (the reverse of the direction of the flame), yet this arrangement is not considered to be of much importance. The furnace is thus maintained at a pretty regular temperature, provided the supply of fuel is properly kept up. This is usually termed "Ekman's system," from the Swedish metallurgist who was the first to apply it successfully.

In addition to mouldings being made at all blast furnaces for the use of the works themselves, or of the forge, or for agricultural purposes, especially when the iron is gray, as is the case, for example, at the commencement of the process, there are in all the provinces iron foundries, which are often combined with iron or tool works for the production of the castings, where the crude metal is melted with coke. The Swedish crude iron is not usually employed alone, but is mostly mixed with Scotch or English iron; but for machinery of great strength iron containing much phosphorus is rejected, and Swedish iron used by preference.

In 1865 the produce of the various iron and steel manufactures, such as steel plates, nails, forged tools, and other wrought-iron articles, was not less than 27,190 tons for the whole country, including the Bessemer steel of Sandviken and Edsken (Gefleborg), of Siljansfors (Stora Kopparberg), and of Carlsdal (Orebro). The province of Carlstad produces the greatest quantity of cemented steel, viz., 850 tons, in several works, of which the principal are Uddeholm, Biörneborg, Lesjöfors, &c. The other works noted for their manufacture of cemented steel are those of Forsbacka (Gefleborg), Elfkarleö (Upsala), Osterby (Upsala), Svana (Westeras), Bofors, Willingsberg, Gryt, Haddebo, and Hellefors (Orebro), Bäckafors (Elfsborg), and Skepsta (Nyköping). Steel plates are made at Motala, Nyby, Surahammar, Kloster, Hallstahammar, Skebo, and Nyköping. Nails are chiefly produced in the provinces of Carlstad, Ostergötland, Kopparberg, Calmar (Gunnebo), and Blekinge (Lyckeaborg). The total production amounts to 5950 tons.

Among the works which manufacture articles for ironmongers, including edge tools and wires, we may mention the Jäden Works.

* "The South Wales refining process is known in Sweden as the Lancashire method, from the workmen who were engaged to introduce it coming from that county."—Dr. David Price in *Scientific Record of Exhibition of* 1862.

* At the Smedjebacken Rolling Mills the iron is drawn for several works, among which are those of Hagge, Grängshammar, Nyhammar, &c., and the mark of the respective works impressed on the bars.

The manufacture of files, carpenters'. and joiners' tools, &c., cutlery and ironmongery, is chiefly carried on in the little town of Carl Gustaf, near Eskilstuna. Many of such articles, however, are imported from England and Germany.

Several of the Dannemora works have combined together for the carrying out of Bessemer's process, with the view of supplying foreigners with an article which may be cast like cemented steel if required, or employed directly for various manufacturing purposes. Numerous specimens of Bessemer steel were shown in the Exhibition.

The subjoined table gives the chemical constituents of the principal Swedish ores; and it will be seen that the small quantities of phosphorus they contain have been determined. Although ores are sometimes found which are entirely free from phosphorus, yet the crude iron always contains a small proportion of it, proceeding from the charcoal ashes, which contain 0·7 per cent of its weight of it. The influence of these small quantities of phosphorus is duly recognized by the workmen. Thus I have observed that two species of blooms, the one containing 0·007 per cent. and the other 0·021 per cent. of phosphorus, have been perfectly distinguished by the workmen, who were re-heating them in a gas furnace, and then drawing them out in bars. The more phosphorus the iron contains the lower is the temperature at which it melts; consequently, if heated to as high a temperature as purer iron, it is liable to break under the hammer, being nearer its fusion point than the latter. The blooms of unwrought iron, containing about 1 per cent. of phosphorus, after being very rapidly melted in low furnaces, and then partially cooled, are in such a fluid state that a great portion of the iron will run off if they are reversed. They break under the hammer if the temperature is too high. The iron combined with about 1 per cent. of phosphorus possesses very nearly the nature of steely iron, or indeed of steel itself. It is a mistake to suppose that the presence of a little phosphorus in the iron is always injurious. It is for the steely irons that it is necessary to avoid phosphorus; for tool irons, such as spades, shovels, hoes, and other agricultural implements, as well as roofing plates, &c., about 0·1 per cent. of phosphorus renders the iron harder and more durable, and tends to preserve it from rust. It is well known that phosphoric iron is not so strong as steel, to which it bears some resemblance.

Name of Blast Furnace and Ore.	Carbon.		Phosphorus.	Sulphur.	Silicium.	Aluminium.	Calcium.	Magnesium.	Manganese.
	Combined.	Graphite.							
Harnas, Dannemora, (gray),	1·04	3·65	0·02	0·02	0·35	—	—	—	—
Ranäs, Dannemora, (salmon coloured),	4·04	0·46	—	0·03	0·46	—	—	—	—
Nykroppa, Persberg, (gray cast iron in the middle of white),	0·59	3·80	0·01	0·06	0·16	0·16	0·26	—	0·06
Langbanshytta, (Langban and Persberg), (white cast iron),	3·68	—	0·029	0·022	0·15	—	0·33	0·13	0·59
Siljansfors, Sorskog, &c., (nearly all gray cast iron),	1·12	3·70	0·007	0·01	—	—	—	—	—
Blast Furnaces of Filipstad (with Persberg ores),	—	—	0·015	0·02	—	—	—	—	—
	—	—	0·021	0·03	—	—	—	—	—
Kloster, Rallingsberg,	4·30	0·19	0·017	0·02	0·11	0·05	0·26	—	0·07
Fagersta, Norberg,	1·01	3·53	0·031	0·010	0·85	—	—	—	1·92
	2·14	2·73	0·026	0·015	0·64	—	—	—	2·93
Granhult, Ramsberg,	—	—	0·026	0·03	0·2	—	—	—	—
	—	—	0·025	0·01	0·5	—	—	—	—
Westansjö, Grangärde, (white cast iron),	4·07	0·69	0·11	—	0·17	—	—	—	—
Finspong, Förola, (gun cast iron),	1·75	2·17	0·05	0·12	0·95	0·17	Trace	Trace	0·19

Mr. V. Eggertz, professor of the School of Mines, Falun, exhibited apparatus for the purpose of determining the qualities of sulphur and carbon present in iron and steel. He has added a description of these methods, as well as of that employed to ascertain the quantity of phosphorus either in the irons or in the ores.* These rapid and ready methods are in general use in the Swedish works, and deserve to be adopted at ironworks on the Continent.

* The method of ascertaining the quantity of carbon is published in *Le Bulletin de la Société Chimique*, 1864, vol. i. The papers relating to the process for determining the sulphur are in the hands of the commission of *Les Annales des Mines*, and the method of ascertaining the quantity of phosphorus will be shortly published.

THE RICHARDSON PROCESS.

SINCE the date of our former papers on this process we are glad to say that it has been again put to a more thorough test; that is to say, a test of duration of far greater importance than those first made at the works of the Glasgow Iron Company. Throughout the whole of the past month several furnaces at the Parkhead Forge have constantly been employed in making iron according to Mr. Richardson's process, giving results that have fully borne out every word that we originally wrote as pertaining to our convictions of what it would effect.

Mr. Beardmore, the managing partner of the Parkhead Forge, feels so confident of the value of the process that he has determined to apply it to several more of his furnaces with the least possible delay; in fact, we may now assert that the value of the process is fully established, on a scale that bears every comparison with the operations of ordinary puddling. Practically speaking, the results which the last month's experience at Parkhead have given may be thus briefly summed together:—A saving of fully a third of the time occupied in conducting the ordinary puddling process, a vastly improved quality of iron, and a higher yield. At these works, where very great care is taken in producing the best quality of plates, and where very gray iron (No. 1 foundry pig) is used for the best qualities, mixed with hematite pig in proportions from $\frac{1}{8}$ upwards, the usual time of puddling a 4-cwt. charge is $1\frac{3}{4}$ hours, and very frequently two hours. This great length of time, however, is chiefly due to the long period of melting of such marks of iron, ranging from thirty-five to forty-five minutes; this being principally dependent upon the larger proportion of silicon combined in such irons, whereas in whiter irons the time of melting is proportionately less.

In some tests which we witnessed as to the bending and breaking qualities of "puddled bars," or "mill-bars," as they are sometimes called, casual, that is unpicked, samples were taken, of what is known at the works as the "common mixture;" the bars produced by the common puddling process were put on the test block, and a few blows of the hammer sufficed to show their cold shortness; in fact the bars readily broke in half, showing a loose and coarsely crystalline fracture, with great want of uniformity. Afterwards bars of similar size made by the Richardson process were similarly treated, when in every case they bent completely over to a right angle on the test block, some of them without even showing a surface crack; in short, the iron thus made appeared in every way as tough and pure as that made of the best mixture used at the works, and in bending the iron back so as to break it, the fracture was of the fineness of steel. Some which we examined under the microscope appeared to be very uniform. There can be no doubt remaining that this process will rapidly make its way in every iron-making country, as soon as its merits have been really understood generally, as they have now begun to be amongst the Scotch, as well as some English iron masters.

One rather singular fact is, that the balling operation appears to take longer in this than under the old process; but a very substantial, and probably valuable, cause appears to exist to account for this. The injection of oxygen by the tubular rabble brings the metal to "the boil" in a few minutes, through the intense temperature produced by its attack upon the carbon and silicon, a temperature which must be greatly exalted above that produced by the old method. Since then the furnace must be lowered in temperature to that of the common method, before the granules of iron will unite and adhere together, it is evident that a longer time must be required to bring the furnace into that condition favourable to the balling of the separated lumps of iron. It being the case, then, that this increased period of balling takes place, it appears extremely probable that this is the reason why the iron is so much purer and stronger; in fact, adding another point in favour of Dr. Percy's now well-known *liquation* or *sweating out* theory, by which he supposes the elimination of phosphorus. There appears to be no other explanation of the remarkable results at present. It is, however, not unlikely that some other more feasible may yet appear; at present, however, we do not see our way clear in any other direction.

In addition to the advantages we have pointed out, the puddler should congratulate himself upon the diminution thus effected of his labour. He may now certainly get his "shift" of six heats out in eight hours, in place of twelve and fourteen under the older method; or, if willing to work the same number of hours, he may produce nine heats per shift, thus adding considerably to his earnings and comfort.

Rightly looked at, beyond the caprice of trades unionism, the Richardson process promises to effect an important saving of labour, tending therefore to place time at command of the operative class for the cultivation of those qualities which would so largely elevate their moral and physical state, and develop that nature wherein each may be taught to become self-dependent, to act for himself, and until which does come about, trade societies, with their rattening ringleaders, will continue; this being, however, one of the remoter effects that must inevitably follow from every improvement in mechanical art applied, when a properly directed use of capital signifies might, and we mean moral, intellectual, as well as monetary capital. These few remarks are but hastily put together just before going to press. We trust next month to give a fuller paper.—V. D.

PARIS EXHIBITION.

ROUFFET'S PORTABLE ENGINE.

(*Illustrated by Plate* 11.)

Amongst the agricultural portable engines shown at the Paris Exhibition, and which attracted our attention, is an engine constructed by M. Rouffet, the following description of which we translate from "Moteurs à Vapeur," by Armengaud Ainé. We are also indebted to the same work for the plate engraving of the Rouffet engine :—

Fig. 1 is a side elevation of the engine with a part broken away to show the arrangement of the fire-box and some of the tubes in section; fig. 2 is an end view of the fire-box; fig. 3, a cross section taken along the line 1—2, with the hind wheels removed; fig. 4 is a plan of the engine detached from the boiler; and fig. 5, a cross section on the line 3—4 of the steam cylinder on the foundation plate.

The mechanism consists of an ordinary horizontal engine, mounted on a foundation plate, secured to the body of the boiler. The boiler is formed of a horizontal cylindrical body, A, united to a vertical cylindrical box, B, containing the furnace, C, and the top of which forms a steam chamber. It is traversed by tubes leading from the furnace to the smoke-box, D, carrying the chimney, E. The whole is supported by two hind wheels of large size, F, and two small fore wheels, F′, the axle of which is arranged to lock, as in ordinary carriages. The wheels are composed of a combination of a cast-iron felly and nave, and wrought-iron spokes, which are cast together. The cylinder, G, is bolted to the plate, H, and the flange to which its cover is secured carries two square lugs to hold the four slide bars, I, the opposite ends of which are secured in the same manner by the supports, *b*, cast in one with the foundation plate. This arrangement admits of the use of an ordinary connecting rod, J, one end of which is forked for its connection with the piston rod, whilst the other terminates in a built head, by which it is united to the driving shaft, K. The driving shaft consists of a cranked axle, mounted on two pedestals, *c* and *c′*, cast on the foundation plate, one of which, *c*, situated at the side where the mechanism is actuated, is made double the size of the other; it is made of good round iron, and bent afterwards at the forge, which mode of manufacture, when the size of the piece admits of its being applied, has the advantage of preserving the continuity of the fibres of the metal, which are only curved, and not compressed or cut asunder. The distance between the pedestals is also sufficientiy great to admit of the crank of the axle being made of such an angle that the iron will not be injured by too sharp a bend. One end of the shaft is provided with a fly wheel, the circumference of which forms a sheave for the direct transmission of the power developed by the engine, and its other end receives an eccentric, M, which actuates the feed pump, N, on the side of the boiler, whilst another eccentric, O, inside the pedestal, *c*, actuates the slide valve.

The steam is conducted from the boiler by a tube, P, provided with a cock, P′, into the slide box, which contains a variable expansion slide on Farcot's system, in order to regulate its admission to the cylinder in the usual way; and it escapes by the tube, *e*, cast on the cylinder through the conduit, *f* (figs. 3 and 5), formed in the plate, H, and a tube, *g*, into the chimney, by which means the draught of the furnace is increased. A governor, Q, is provided, which acts on a throttle valve, *d*, in the steam pipe, and is mounted on a curved bracket, R, secured to the top slide bars, I, and receives motion from the driving shaft by means of a strap, h^2, and the two pulleys, *h* and h^1, one of which, h^1, is fixed to the end of a shaft, *i*, mounted on the bracket, R, and which carries a bevel wheel, *j*, gearing with a corresponding bevel wheel, j^1, on the axis of the governor. The movable socket of the governor is attached to a knee, *k*, in connection with the connecting rod, k^1, which through the small crank, k^2, regulates the valve.

This engine, being mounted on wheels, is intended for work in the field or yard, and may be readily transported from place to place when required, with the steam up ready for work; but it often happens that it is required to be used in a shop instead of a fixed engine, where from local circumstances a fixed engine could not be employed, in which case the wheels may be temporarily substituted by two cast-iron supports with their top part made of a cylindro-concave form to embrace the boiler, and resting on the ground; the engine thus becomes half fixed, whilst it may with great facility be removed from its place, or from the shop, without the necessity of dismounting any of the parts.

The furnace, C, is of cylindrical form, made flat on one side to receive the tubes, and secured by angle irons to the bottom of the box, B; it is also secured to this outer box by the plate, *l*, at the point where both of the boxes are perforated for the introduction of the fuel, with apertures closed by a door, *m*. The fire-bars, *n*, are supported on a cast-iron frame, attached on one side by lugs to a horizontal rod, *o*, carried by brackets, and supported at the other side by a simple movable latch, *p*, the object of which is to facilitate the rapid clearance of the grate by turning over the fire-bars, which is effected by moving the latch, *p*, until the frame is released, when it will turn round its centre, *o*, and the ashes on the bars will fall out. The tubes, S, are mounted and secured with bushes on the side of the furnace and of the smoke-box, D; they are twenty in number, eighteen of which are disposed in three rows, the other two alone forming the fourth row, with a space between them for the passage of a scraping rod, which is introduced for the purpose of cleaning the boiler and extracting the deposits. A similar apparatus, *q*, is arranged at the lower part of the box, B, for the extraction of the deposits which always accumulate more at that part, it being the lowest part and the point where evaporation most takes place. Another and larger door, *q′*, of rectangular form, is placed on the box, B, to facilitate the introduction of a lamp for an examination of the state of the boiler.

The cylindrical body has a very limited space at disposal for a steam chamber, and therefore the box, B, is made of considerable height, and forms a steam chamber. There is also a brass dome on the top, where the tube, P^2, leading to the cylinders opens in the form of a rose jet, to prevent water being carried away with the steam. The smoke-box is secured to the end of the boiler, and is provided with a door, which may be opened for the purpose of sweeping the tubes and slackening the draught when the engine is not at work. The chimney is formed of a fixed part, E, rivetted on to the smoke-box, and of a hinged prolongation, E′, which may be turned down to the position shown by the dotted lines (fig. 1) when it is required to remove the engine. The boiler is provided with two safety valves, mounted on a common seat, T, a glass water gauge, U, two gauge cocks, V, and a Bourdon pressure gauge, X. The whole of the boiler is protected by a coating of felt covered with wood, and this is again inclosed in a covering of sheet iron. The plate, H, is rectangular for the greater part of its length, and enlarged at the pedestals, between which it is hollowed out to make room for the connecting rod and the crank of the shaft. It is secured to the boiler by six bolts, *s*, corresponding to an equal number of lugs. The feed pump, N, is disposed obliquely on the boiler by means of a flange fixed on to an inclined solid bracket, *u*, slotted for the passage of the two bolts which secure it. The water is drawn from a temporary reservoir through the pipe, N^1, a cock, *v*, being provided to regulate the supply; but when a permanent reservoir is close at hand, a hose may be substituted for the tube, N; the water is introduced into the boiler by the pipe, N^2, the cock, *x*, of which should never be closed whilst the engine is at work, but only when the engine is at rest, when it is required to dismount the pump while the boiler is full of water, or for any similar purpose.

This engine, provided with variable expansion gear, is a nominally eight horse-power; the shaft makes ninety revolutions per minute; the pressure of steam is equal to six atmospheres; and the cut-off is at one-quarter stroke.

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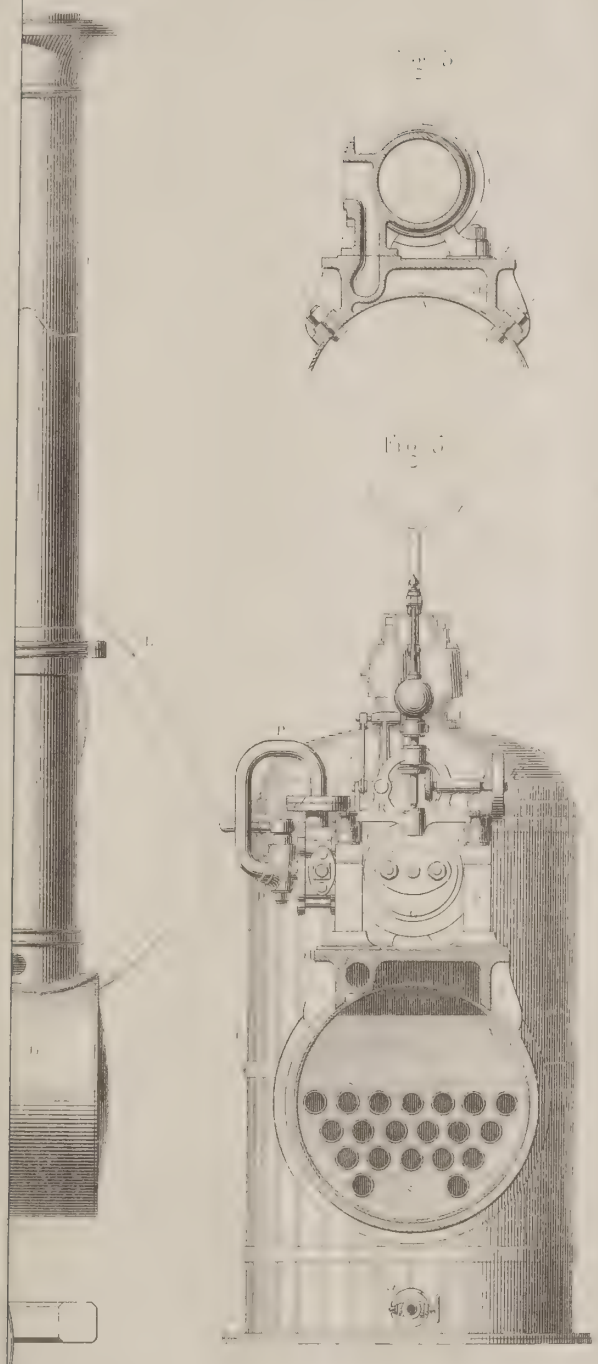


Fig 3

Fig 5

Scale

Patent Off
and 16

PORTABLE ENGINE,
BY M. ROUFFET.

Fig. 2

Fig. 1

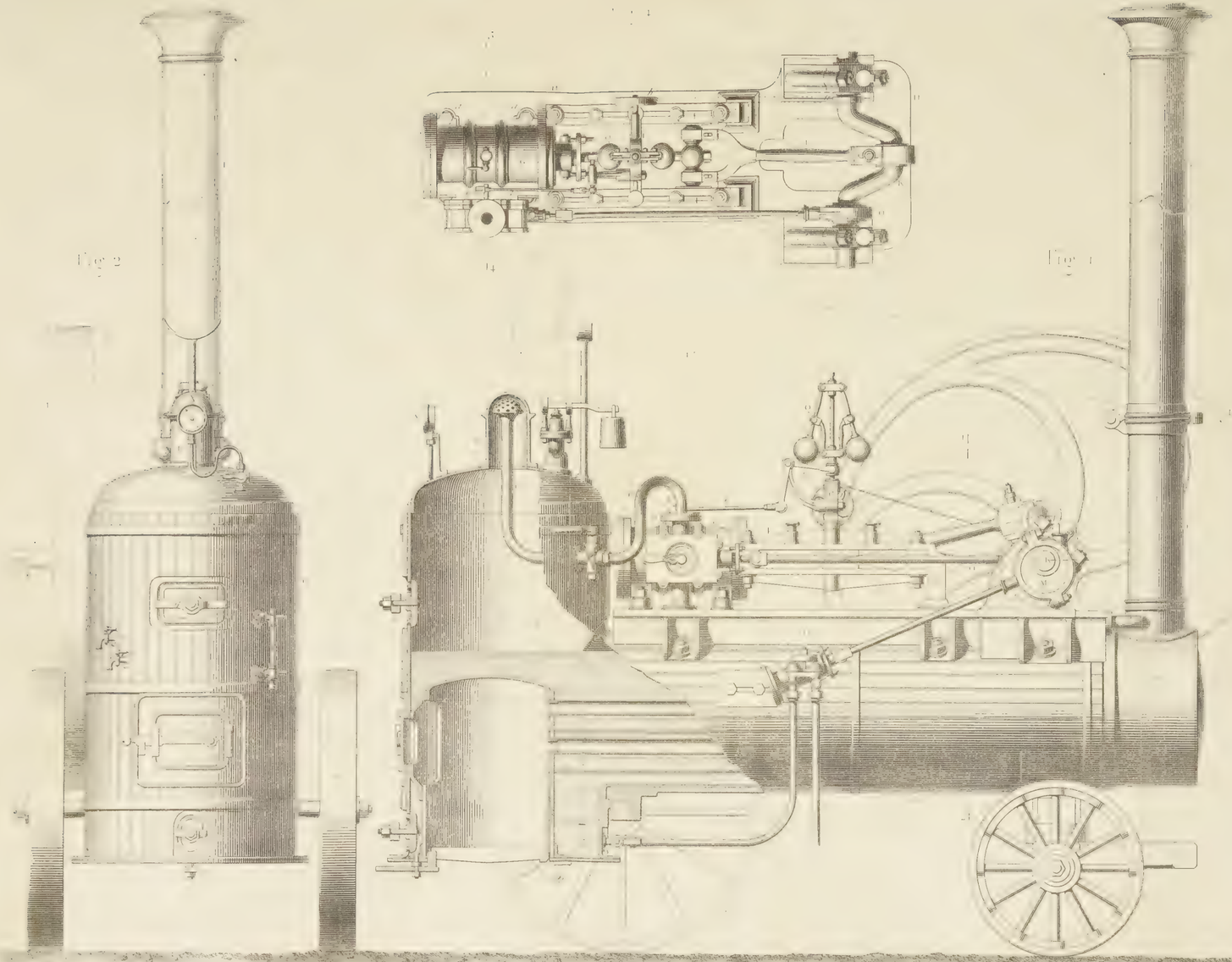


Fig. 5.

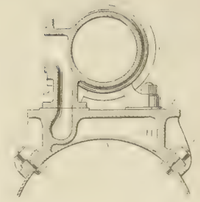
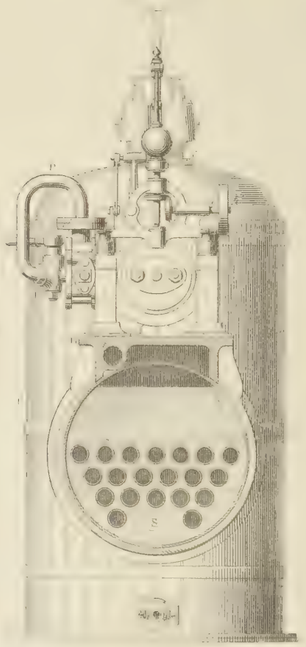


Fig. 3



Scale

MINGAUD AÎNÉ

RECENT PATENTS.

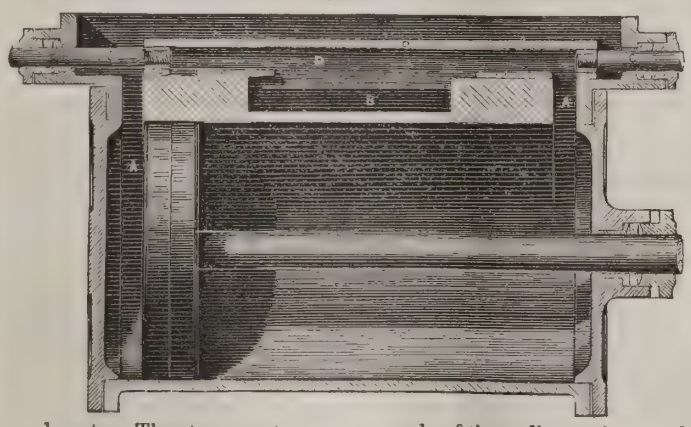
VALVES FOR STEAM ENGINES.

BERNARD P. WALKER, *Wolverhampton.—Patent dated 12th March*, 1867.

THIS invention relates to the slide valves and corresponding valve ports or passages of steam engines, and also to conical or disc valves for regulating the flow of steam and other fluids under pressure, and has for its object the partially or wholly balancing the pressure on such valves. In constructing and arranging a slide valve and ports according to this invention, in place of disposing the steam and exhaust ports of the cylinder face with their greatest length at right angles to the movement of the valve, the exhaust port is arranged with its greatest length at right angles to the steam ports, and in the direction of the motion of the slide valve. The slide valve, in place of having an opening or recess on its under surface sufficiently large to embrace the exhaust port and one of the two steam ports, with the space between them, consists simply of a hollow box, provided on the working face with three openings arranged similarly to the three ports in the cylinder face, but so disposed that the central or longitudinal exhaust port in the valve will always work over the corresponding port in the cylinder face, whilst one or other of the transverse ports or openings will correspond alternately with one or other of the steam ports in the cylinder face; by this means the unbalanced area of the slide valve due to the exhaust port, may be reduced to what is due to the actual area of the steam port alone, and this without affecting the lap or "cut off" of the slide valve, whereas in an ordinary slide valve the unbalanced area is equal to the area of the exhaust and steam port, and the intervening space combined. This construction of slide valve also affords facility for lengthening the valve so as to cut off the steam close to the top and bottom of the cylinder, without increasing the unbalanced area. In constructing an equilibrium conical or disc valve according to this invention, the spindle of the valve is secured to an elastic cover or bonnet, which may be composed of one or a series of elastic metal or other discs secured together, or of india-rubber or other suitable elastic material; such elastic cover or bonnet yielding sufficiently to allow of the rise and fall of the valve, and being of sufficient area to balance the pressure on the valve. By making this elastic cover steam and fluid tight, the necessity for stuffing boxes is avoided.

Fig. 1 of the engravings represents a longitudinal vertical section of a cylinder provided with the improved construction of slide valve

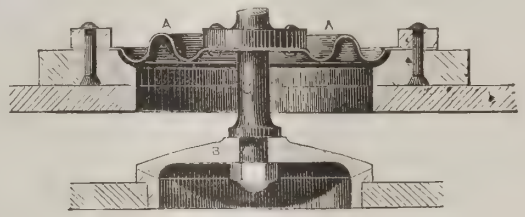
Fig. 1



and ports. The steam ports, A A, are made of the ordinary shape and proportions, whilst the exhaust port, B B, is made of the same, or nearly the same, area with the steam ports, and arranged, as shown, with its longer sides parallel with the axis of the cylinder, by which arrangement the area of the exhaust is but slightly diminished by the motion of the valve, even when the aperture in the face of the valve is made of the same dimensions with the exhaust port of the cylinder. The valve may be cast either of iron, gun metal, or other suitable material, or may, by preference, be built up of sheet metal, the back being of boiler-plate iron, and the face of steel. It consists of a hollow box, having rods, C C, attached to it for connecting it with the eccentric, or other gear for actuating it in the ordinary way. Its face, or that side which is in contact with the cylinder face when arranged for working, has three apertures, which are made to correspond with those in the cylinder face, so that the central one and one of the end ones shall be coincident with one of the steam ports alternately and the exhaust port. The valve is seen with portions of the back removed, so as to exhibit the arrangement of the steam and exhaust ports, A A and B, the right-hand steam port being in the position shown in connection with the exhaust, and the left-hand port receiving steam, the piston passing from left to right. In cases where the stroke of an engine is very short relatively to the diameter of the cylinder, two exhaust ports are used, and arranged as before described, with the longest side parallel with the axis of the cylinder.

The second part of the invention has for its object the getting rid of the pressure which has to be overcome in opening ordinary conical puppet or spindle valves under steam, or other fluid pressure, and is illustrated by fig. 2. Instead of, as is usual, constructing valves of

Fig. 2.



the above-named kind with a stuffing box through which the valve spindle passes, an elastic cover or bonnet is used, to which the valve is attached by means of a spindle. This bonnet is in one arrangement, composed of discs of steel or other suitable material connected together by rivetting and soldering, or any suitable method, so as to permit the spindle to rise and fall by the bending of the discs, thus allowing the valve to rise for the admission of steam. It is evident that the upward pressure of the steam against the bonnet will, if the proportions of area are correctly preserved, balance the downward pressure upon the valve. Motion is given to the valve by an attachment to the spindle or bonnet from the outside, as will be readily understood. When the lift of the valve is not required to be great, a single plate of steel or other suitable material is used, and corrugated, so as to allow of its springing in a direction perpendicular to the valve, as shown in fig. 2.

HAMMERS.

J. HENRY JOHNSON, *London and Glasgow.—A communication from* GEORGE SELSOR *and* WILLIAM COOK, *of Philadelphia, U.S.—Patent dated 10th April*, 1867.

THIS invention consists of the combination, substantially as described hereinafter, of claws with the "pein" of a hammer head, so that the latter can be used for performing duties, to accomplish which has heretofore required two separate hammers. The invention further consists of a groove formed in the "pein" of the head, beneath the claws, for the reception of a nail, which can be driven to its place without the usual manual adjustment.

Fig. 1 of the engravings represents a side view of a hammer

Fig. 1.

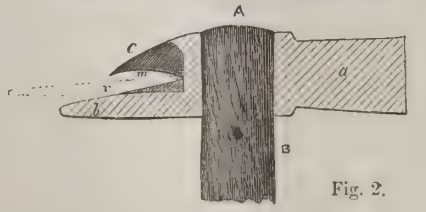


Fig. 2.

head, with the improvements applied thereto. Fig. 2 is a plan view of the same.

A is the head of the improved hammer, and B the handle, the latter

being secured to the frame by any of the means heretofore employed for the same purpose. On one end of the head there is formed the usual 'pole,' *a*, and at the opposite end the 'pein,' *b*, above which are the claws, *c*, there being between the 'pein' and the claws a space, *m* (fig. 1), sufficiently large to admit the head of an ordinary nail.

The heads of common hammers have usually been made either as claw hammers, or as rivetting hammers. The two styles are combined in the improved hammer, which, as will be readily seen, can be used either as a carpenter's hammer for driving and drawing nails, and other purposes, or for any of the duties for which a rivetting hammer is required.

In the upper surface of the 'pein,' *b*, and below the claws, *c*, a groove, *x*, is cut in which can rest a nail, as shown in fig. 2, the head of the nail being in contact with the end of the recess, *m*, between the claws and the 'pein.'

In many instances it becomes necessary for a carpenter or other operative to drive a nail at a point where it cannot be readily reached, to be adjusted and steadied by one hand whilst being driven by the hammer in the other hand. In such cases the nail may be placed in the groove, *x*, as shown, and being maintained in a proper position laterally by the groove, may be elevated with the hammer, and driven at any point within reach of the hammer head.

This invention may be applied to hammers having 'peins' of different shapes from that shown and described.

PACKING RINGS.

JOHN M'LINTOCK, *Barnsley.—Patent dated 27th February*, 1867.

THIS invention consists essentially in constructing a light and durable packing for the stuffing boxes of piston rods, pump rods, valve spindles, and other parts of machinery requiring such packing of vulcanized india-rubber, or other suitable elastic material faced or lined with metal on the inner or rubbing surface of the packing. In carrying out the invention, a split ring of vulcanized india-rubber, combined or not with fibrous material, is constructed and to the inner or rubbing surface thereof—there is adapted a lining of sheet copper, brass, steel, or other suitable metal, which may be secured to the india-rubber ring, by having tongues formed upon the metal lining, and bending such tongues over the upper and under, or upper or under surfaces of the ring. In some cases, however, these tongues may be dispensed with. The split, or opening in the ring and metal lining, is bevelled or stepped, so as to prevent the escape of steam or other fluid at the joint; or two or more packing rings with a straight split may be *superposed*, and so placed as to break joint with each other when in the stuffing box. This compound packing ring, or rings, is or are introduced into the ordinary stuffing box, and is or are compressed or tightened up as required by the usual gland and tightening screws.

Fig. 1.

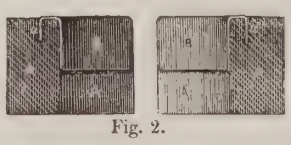


Fig. 2.

Fig. 1 of the annexed engravings represents a plan of a piston rod packing ring, constructed according to this invention, and fig. 2 is a cross section of the same. A represents the elastic material composing the body of the packing ring; this may consist of vulcanized india-rubber, or other suitable elastic material. I have found that a ring composed of a strip of canvas, impregnated with india-rubber and coiled upon a mandril of the desired size, answers well in practice; but it is obvious that various materials and methods of manufacture may be employed in making these elastic packing rings. Within the elastic ring so formed is introduced a lining or facing of sheet copper, brass, steel, or other suitable metal or alloy in the form of a split ring, B; and in order to secure or hold such metallic lining in its place it is preferred to cut or indent one or both its edges, so as to form a number of sharp teeth or points, as shown at *a*, *a*, which are bent over and inserted into the body of the elastic ring, as will be readily understood on referring to the sectional elevation, fig. 2. In this figure the points, *a*, are represented as being formed upon one edge of the metal ring, B, and inserted into one face of the elastic ring, A; but if found desirable, the metallic ring or lining may be similarly secured on both its edges, or the points, *a*, may be dispensed with entirely.

When applying these packing rings it is simply requisite to open the ring sufficiently to enable it to pass on to the rod or shaft to be packed, and then to close the ring until it will enter the stuffing box. In order to fill the cavity in the bottom of the stuffing box, when requisite, a packing or washer of hemp or other like material is interposed between the improved compound packing ring and the bottom of the stuffing box, a similar packing or washer being introduced between the end of the stuffing-box gland and the compound packing ring, so as to fill up the entire cavity of the stuffing box.

RAG ENGINES.

JOHN R. CROMPTON, *Bury.—Patent dated 22nd February*, 1867.

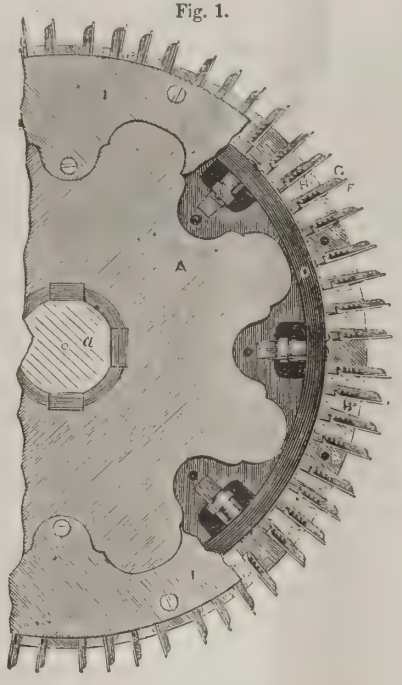
THIS invention relates to improvements in the roll and bottom plate of rag engines employed in cleansing and reducing fibrous material to pulp, whereby the necessity for grinding or renewing the edges of the grinders or bars and plates is obviated, and consists in the employment of a series of adjustable bars or strips of steel as grinders which are of the same, or nearly the same, thickness throughout, so that the actual cutting edge will remain uniform, or nearly uniform, as the grinders wear away. These adjustable steel bars, or grinders, are supported by fixed iron or other metal backing bars in the circumference of the roll, and their adjustment for wear is effected by having a projection made on the inner edge of each grinder, which fits into one or other of a series of grooves or notches made to receive it, on the faces of the fixed backing or supporting bars; wooden slips or wedges are inserted in the space between one face of the steel grinder and the face of the next, or succeeding backing bar, so as to assist in holding the several steel bars, or grinders, in their places. These wooden slips are secured by a hoop, or ring of brass or other metal taking into an annular groove at each end of the roll; such hoops or rings being by preference made in segments for convenience of adjustment, and being held in their places by screws, bolts, or otherwise. The hoops or rings may be either bevelled on the outer periphery and on their inner face, so as to act as a dovetail in holding the slips and steel grinders in their places; or in lieu of bevelling such rings they may be provided or formed with teeth or projections on their inner faces, taking into corresponding notches in the ends of the slips and iron supporting or backing bars.

The bottom plate of the engine is composed of a series of steel blades similar to those employed in the roll, bolted together and capable of adjustment vertically, so as to compensate for wear between and in the dividing bars, by the aid of notches and projections, as described in reference to the roll, or by other suitable or equivalent contrivances.

Fig. 1 of the annexed engravings represents a partial end elevation and transverse section of a rag engine roll constructed according to this invention. Fig. 2 is a corresponding side elevation and partial vertical longitudinal section of the same; and fig. 3 is a full-sized detail of a grinder and its backing bar detached. A is the body of the roll keyed on to a shaft, *a*, and on the periphery of this roll are a number of projections, B B, running the whole length of it. In the spaces thus formed between these projections, any convenient number of grinders or blades of steel, F F, are placed, and a like number of stronger blades or backing bars, G, which may be made of steel, iron, or brass. These latter are intended as a support to the plates of steel which constitute the grinders. The grinders, with their supporting bars, G, at the back of them, are kept at suitable distances from one another by wedges or dividers of wood, H H. Between each space formed by the projections on the periphery of the roll an iron wedge, C, is placed. This wedge and the wood dividers, steel grinding blades, and backing bars, are all made to fill up the space between each projection. At each end of the roll a groove is formed for the reception of a hoop, D, and a corresponding groove is also formed in the ends of the iron wedges, C, for these hoops to fit in. The hoops are fitted with screwed bolts, E, at each point where they intersect the wedges, C, and the object of these bolts is to draw down the wedges towards the centre of the roll. By this action of the wedges, C, the whole series of grinders, backing bars, and dividers, are made to fit tight and securely in the spaces allotted to them between the fixed projections, B, on the periphery of the roll.

To prevent the pulp or material to be operated upon from getting into the grooves and recesses necessarily formed in the end of the roll for the reception of the hoops and bolts, it is preferred to cover up the whole with segments of brass plates, I, made secure with screws into

Fig. 1.



the solid ends of the roll. These plates are also made to serve as a further security in checking the tendency which the grinders and other parts have to fly out by the action of centrifugal force. For this purpose the plates have a flange or projection on their inner face, which is made to fit into a groove turned into the ends of the grinders, backing bars, and dividers.

The engravings show the grinders projecting about a quarter of an inch above the backing bars, and when the grinders are worn down to

Fig. 2.

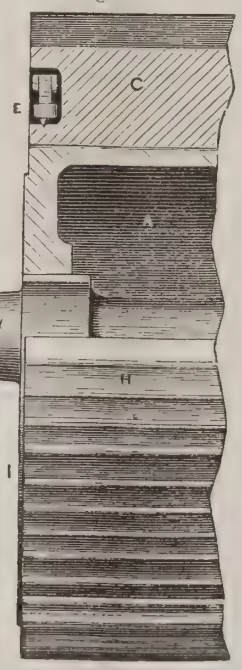


Fig 3.

the edges of the backing bars the roll is constructed so as to afford an easy means of raising them up at intervals as required, to compensate for wear and tear. For this purpose there is a series of grooves formed in the front face of the backing bars, as shown clearly in the detail, fig. 3. The steel grinding blades have a flange or foot at their lower edge, running the whole length of the blades, and this fits, in the first instance, into the bottom groove of the backing bars, and is consecutively raised into the others as the grinders wear away, thus allowing the edges of the grinders constantly to project above the edges of the backing bars.

The operation of raising the grinding blades is accomplished in the following manner:—The brass end plates, I, are first removed by taking out the screws that hold them to the body of the roll. This gives admission to the bolts, E, which hold down the iron wedges, C, and by slackening these bolts the wedges are raised, thus liberating the grinders, backing bars, and dividers. The grinders are now raised into the next groove of the backing bar, and the whole are again made secure by tightening down the wedges and replacing the end plates, when the roll is again ready for work. This process is repeated each time the grinders become worn down to the edges of the backing bars.

The grinding blades, according to this invention, not being tapered or bevelled, maintain one uniform grinding edge, and this edge may be adapted, by the thickness of the steel blades, to that most suitable for the nature of the material to be operated upon. The facility with which the grinders can be taken out of the roll is a great improvement on the old plan of constructing a roll.

As the grinders only wear down about a quarter of an inch before they are again raised, the roll never varies more than about half an inch in diameter, and the spaces between the grinders requisite for the purpose of drawing in the material, and keeping up the circulation of the same, is maintained nearly uniform. Considerable economy is obtained both in time, steel, and motive power over the method of construction hitherto adopted, wherein it has been usual to permanently fix on the periphery of an iron or wood roll a series of steel blades, bevelled or tapered to a requisite cutting edge. Now, as this edge, in the ordinary wear and tear of grinding against the bottom plates, became too dull, it was customary either to chip on a fresh bevel or to take the roll apart and replace with new grinders, or forge out the old ones to a new bevel.

LAW REPORTS.

BLAKE *v.* ARCHER.—STONE-BREAKING MACHINES.—Before Vice-Chancellor Sir W. Page Wood, November 12. This was the trial before the court itself, without a jury, of certain issues which had been directed in a suit in which Messrs. Blake, of Newhaven, in Connecticut, in the United States of America, are plaintiffs, and Messrs. Thomas Archer & Son, of Duniston Engine Works, Gateshead, are defendants. The suit was instituted to restrain the alleged infringement by the defendants of certain letters patent dated June 14, 1858, granted to Mr. John Henry Johnson for "improvements in machinery or apparatus for breaking or crushing stones for road metal and other purposes, and for crushing ores and other hard and brittle substances." The actual inventor of the machine was Mr. Eli W. Blake, one of the plaintiffs, and the patent was taken out by Mr. Johnson, as for an invention communicated from abroad, and as agent for Mr. Blake, and the beneficial interest in the patent had now been vested in the plaintiffs.

The issues to be tried were the usual issues in such cases, involving the novelty of the invention, the sufficiency of the specification, and the fact of infringement.

Mr. Grove, Q.C., Mr. Giffard, Q.C., and Mr. W. N. Lawson (instructed by Mr. John Henry Johnson, of 47 Lincoln's Inn Fields and Glasgow) appeared for the plaintiffs; and Mr. Manisty, Q.C., Mr. Druce, Q.C., and Mr. Theodore Aston (instructed by Messrs. Combe & Wainwright) appeared for the defendants.

The material parts of the plaintiffs' specification were as follows:—"The invention relates to a peculiar construction, arrangement, and combination of mechanism, to be driven by steam or other power, for breaking or crushing stones for road, metal, or other purposes, or for crushing quartz or other hard substances containing minerals. This apparatus consists essentially of a pair of vertical jaws, the one being fixed and the other movable, or, if found desirable, both jaws may be movable. These jaws have their acting faces corrugated vertically, and such acting faces are made also convergent downwards one towards the other, so that, whilst the space between them at the top, when the stones or other hard substances are introduced, is sufficiently large to receive them in an unbroken state, the space between the jaws at the bottom is only sufficiently large to allow the fragments to pass through after they have been crushed or broken to the required size. A short but powerful vibration is imparted to one or both of the jaws by any convenient arrangement and combination of powerful levers, worked by a crank or eccentric on the main shaft." The patentee then stated that he preferred to employ one movable jaw only (and this is the form in which the invention has been brought into public notice), and to actuate such jaws by a combination of knee or toggle joint with a powerful lever, worked from a crank of short stroke on the main shaft, which may be fitted with a suitable flywheel and driving pulleys. The specification then continued:—"By the above described form and arrangement of jaws, and the motion of the movable jaw, when a stone or other hard substance is dropped into the space between the jaws it falls down by its own gravity until it is arrested by their convergent faces, and the movable jaw advancing crushes the stone, the fragments of which are then partially liberated by the back stroke of the jaw, effected by a spring for that purpose, and descend by their own gravity further down.

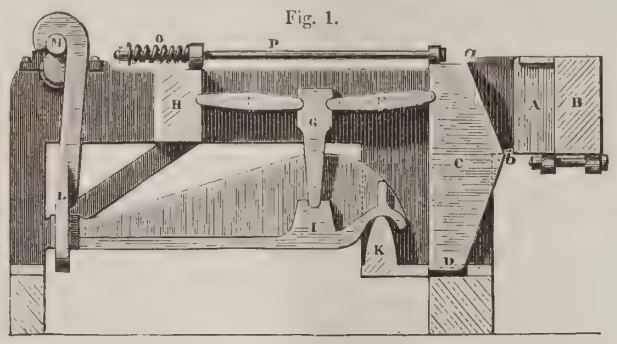
when the next stroke of the jaw will crush them still smaller, and so on until the whole of the fragments are sufficiently reduced to pass through the bottom space between the jaws." After describing the machine by reference to drawings annexed to the specification, the specification concluded as follows:—"I do not confine or restrict myself to the precise details or arrangements which I have had occasion to describe or refer to, as variations may be made therefrom without deviating from the principles or main features of the said invention; but what I consider to be novel and original, and therefore claim as the invention secured to me by the hereinbefore recited letters patent, is the peculiar combination of mechanical parts into a machine for breaking stones or other hard substances, as hereinbefore described."

The plaintiffs' machine was exhibited in the International Exhibition of 1862, and a prize medal was awarded by the jurors to Mr. Blake for his invention.

The defendants were alleged to have infringed the plaintiffs' patent, by selling machines which were made under certain patents obtained by Mr. Thomas Archer, jun., in 1864 and 1867. This machine was described as consisting of a strong frame or trough, with curved or inclined corrugated sides. Inside this frame the defendants caused a set of what some of the witnesses called knives or cleaving instruments, and others called hammers, to act separately and independently on the stone intended to be broken, one set advancing and the other retreating at the same time; these being successively forced against, and withdrawn from the surface of the corrugated sides, the stone, or ore, or other hard substances placed in the trough, would be crushed or broken, and would fall through the opening on to the ground.

The defence on the question of infringement was, that the machine was an

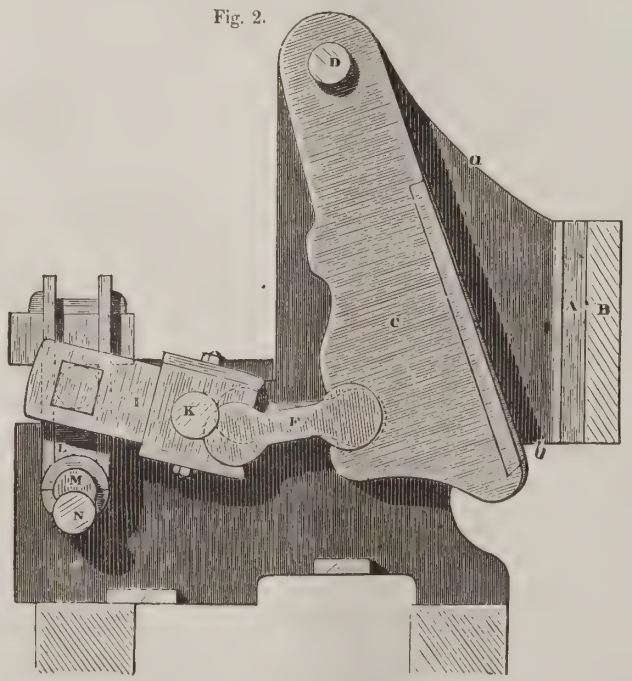
Fig. 1.



improvement on plaintiffs' machine, and was so different from it as to constitute an essentially distinct invention. On the question of novelty the defendants set up three specifications, dated previously to plaintiffs' patent, viz., Richards & Grose, 1852, Hamilton, 1854, and a provisional specification of Collyer, 1854. The latter specification was ultimately abandoned by the defendants' counsel.

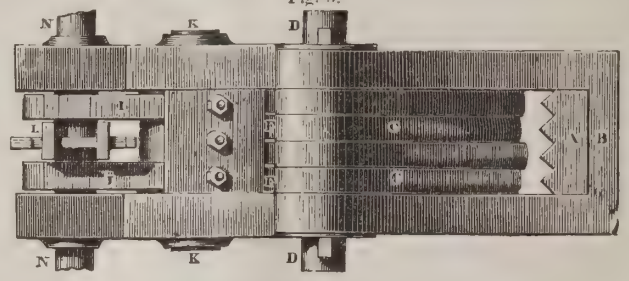
Fig. 1 represents a longitudinal vertical section of the plaintiffs' machine as specified. It consists of a fixed jaw, A, placed against and secured to one end of

Fig. 2.



the main frame, B. C is a movable or oscillating jaw, which extends downwards, and works in a mortice or recess in the lower transverse part, D, of the main frame. The stones to be crushed are thrown into the space, *a b*, between the acting faces of the jaws, A and C. As the acting face of the movable jaw, C, converges or inclines downwards towards the lower edge of the acting face of the fixed jaw, A, it follows that the intervening space between the jaws at *a*, where the large stones are first cast in, will be considerably greater than at *b*, where the broken or crushed fragments drop out. The acting faces of these jaws are not plain surfaces, but are corrugated, such corrugations running vertically, and tending more effectually to break up the stones into fragments of an approximate uniform size. The plaintiff in his specification states that any convenient arrangement and combination of

Fig. 3.



powerful levers, worked by a crank or eccentric on the main shaft, may be used for imparting a short but powerful vibration to one or both of the jaws. The arrangement he describes consists of two plates, E, F, fitting into notches in the central movable piece, G, and in the movable jaw, C, and fixed cross-bar, H, of the main frame, respectively. The piece, G, articulates at its lower end on the lever, I, which works on a fixed fulcrum, K, at one end, whilst the other end of the lever is connected by the link, L, with a crank or eccentric, M, on the driving shaft, N. The spiral spring, O, through the medium of the rod, P, tends to hold the movable jaw back, thereby keeping the parts E and F in contact with their bearings, and insuring the return motion of the jaw. The driving shaft, N, is rotated by the aid of a pulley and driving strap from any prime mover; and a flywheel is provided to equalize the motion. On rotating the crank a vibrating motion will be at once imparted to the lever, I, which, through the medium of the pieces, G, E, F, will give a short and powerful vibration to the movable jaw, D.

Fig. 2 represents a sectional elevation, and fig. 3 a corresponding plan of the machine made and sold by the defendants. The corresponding parts in the two machines are indicated by similar letters of reference. A is the fixed corrugated jaw, secured to the end of the main frame, B. C is the series of movable or vibrating jaws, all of which are free to oscillate independently of each other on the fulcrum pin, D, from which they hang downwards. E is one of a series of toggles corresponding to the several plates or jaws, these toggles working at one end in a knuckle joint in the jaws, and at the other in knuckle joints disposed alternately above and below the fixed fulcrum or centre of vibration, K, of the lever, I. This lever derives its vertical rocking or vibratory motion from the eccentric, M, on the driving shaft, N, through the medium of the link or connecting rod, L. *a b* represent the tapering space between the fixed and movable jaws into which the stones to be crushed are introduced. As the toggles, E, are centred alternately above and below the working centre, K, it follows that on vibrating the lever, I, they will alternately advance and withdraw the several jaws or vibrating plates, the one advancing so as to crush a stone whilst the next adjoining one is receding.

Fig. 4.

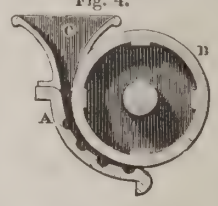


Fig. 4 represents a sectional elevation of the machine for pulverizing ores, described in the prior specification of Richards & Grose's patent, dated July 15, 1852, and relied on by the defendants as a prior publication of the plaintiffs' invention. This machine is described in the specification as consisting of a fixed plate, A, and revolving reducing cylinder, B. The space in which the ore falls from the hopper, C, is large at the mouth, and decreases gradually down to the bottom of the fixed plate, when the ore will issue in a pulverized state. The effect of this machine is in fact a grinding or rubbing action upon the ore, in contradistinction to a mere nipping action, as in Blake's machine.

Fig. 5.

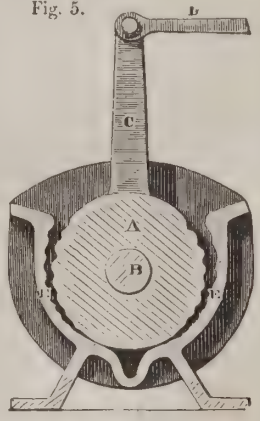


Fig. 5 represents a sectional elevation of the essential part of another machine for crushing quartz and other substances, described in the specification of the prior patent of Hamilton, bearing date the 1st of May, 1854, and also relied upon by the defendants. In this machine a pestle and mortar or rubbing action is obtained. It consists of a cylindrical pestle, A, mounted on a shaft, B, so as to be capable of vibrating or rocking on its centre through the intervention of the connecting rod, C, attached to the lever arm, D, and worked by a crank, not shown in the engraving. This cylindrical pestle is contained in a basin or mortar, E, having a semicircular bottom, and slightly larger than the pestle; consequently, as this pestle rests on the bottom of the basin, the distance between the pestle and the inside of the basin gradually increases towards the top of the basin; and near the upper part of the basin corrugations or flutes are formed, and also on the upper surface of the pestle similar flutes are formed. The substances to be broken are fed into the spaces on each side of the rocking or vibrating pestle, and are gradually broken smaller and smaller as they descend, until they are finely ground and comminuted by the action of the smooth surfaces of the pestle and mortar combined. The only other prior publication relied upon was an expired provisional specification of R. H. Collyer, dated a few days prior to Hamilton's, and describing, strange to say, but without the aid of drawings, an arrangement precisely similar to Hamilton's.

The plaintiffs' contention as to these prior specifications was, that they disclosed a perfectly different action to that of plaintiffs' machine, viz., a grinding or rubbing action, as distinguished from the action of two surfaces approaching each other, and then receding; and further, that there was nothing to show that the invention there mentioned had ever been or could be worked.

Mr. Grove, Q.C., opened the case for the plaintiffs.

It was agreed between the counsel for the plaintiffs and the defendants that, to save time, it should be admitted that machines made in the manner complained of had been sold by the defendants to Messrs. Myers & Co., Messrs. Mowlem, Freeman, & Burt, and the Mount Sorrel Granite Co.

The following witnesses were then called:—

Mr. Henry Donlevy, a commercial traveller, stated that he had visited the works of Messrs. Myers & Co., and had there seen one of the machines complained of, which he stated was similar to the plaintiffs' machine. He had also visited the works of the defendants, and there seen machines similar to plaintiffs' in course of manufacture.

Mr. J. H. Johnson, the patentee, and solicitor of the plaintiffs, proved the facts above stated as to the circumstances under which the patent was obtained, and the beneficial ownership of the same.

Mr. Henry Rowland Marsden, one of the plaintiffs, and the agent in England of Messrs. Blake, proved the introduction into England of Blake's machine in the Exhibition of 1862. He had made three machines exactly according to the specification and drawings. They worked well. Defendants' machine had all the essential qualities of that patented by plaintiffs. The mechanical part alone was different. Before Blake's machine, he did not know of any stone-breaking machine which had jaws. The witness stated, in effect, that the substantial alteration made since the patent, was substituting a movable jaw working round a pivot at the upper part of the machine, for a movable jaw working round a pivot at the bottom, as figured in the drawing in the specification.

Cross-examined.—The position of the movable jaw, as originally made, was not found to create any impediment in the work. An alteration had also been made in that part of the machine which actuated the toggle joint. The form of the corrugations had also been varied. He had made in the United States the best road metal he had seen, by the original machine. The witness was further cross-examined with a view to show that the effect of the fluted corrugations as now made by the plaintiffs, was different from that of the waved line shown in the drawings to the specification, and produced the action of splitting the stone rather than crushing it. Plaintiffs, very soon after the date of the patent, made the movable jaw in different pieces like the defendants, for convenience of transportation, but have used them bolted together as one piece.

Re-examined.—The face of the jaw is made suited to the nature of the materials and the fineness required. Pulverization was not the object of the machine.

Mr. Robert Mallet, F.R.S.—Stones for road making were in former times broken by hand. Attempts had been made to start machinery for crushing stones; two cast-iron rollers (one being corrugated) were used, and stones were passed through them; the action was that of two surfaces passing one another; stamping machines were also used; all these were perfectly different to Blake's machine; the essential feature of that invention was simply two jaws approaching one another, and then receding; that was, in witness' belief, new at the date of the patent; the machinery described in the specification would work, and was described sufficiently to enable an ordinary workman to understand the invention. Richards & Grose's specification did not anticipate plaintiffs' patent; the combination shown there was only the old grinding and crushing roller; the action was a rubbing action. The same remark applied to Collyer's & Hamilton's specifications. Had seen the defendants' machine at Mowlem & Burt's; in principle it was perfectly identical with plaintiffs' machine. In both were two jaws practically vertical, and in one (defendants') the jaw advances here and recedes there. Whether you have one jaw, or a number of jaws alternately advancing and receding, it is the same thing. If the jaw be in several pieces alternately advancing and receding, the effect would be the same as a corrugated solid jaw.

Cross-examined.—If, instead of having two solid jaws, you bring one of the pieces of a jointed jaw against a sharp point opposite, that would not be breaking the stone without crushing it. It is not possible to fracture a stone without crushing it. Hamilton's specification is nothing but a mere succession of rollers.

Mr. James Nasmyth, C.E., stated that he agreed with the evidence of the last witness. The specifications produced by defendant do not anticipate plaintiff's invention. The essential difference between Blake's and those machines, is that the latter are crushing actions produced by surfaces passing each other, whereas in Blake's the crushing action is produced by a direct approach and recession. The only difference between Blake's machine and that of defendants', is the splitting up of the jaws. Had seen one of Blake's machines at work on emery rock; it broke it up in a most masterly manner.

Cross-examined.—There were angular corrugations on the plaintiffs' machine which I saw. In the machine as specified by Blake, the fulcrum is at the bottom, and in the one as used it is at the top. When the fulcrum is at the top you get more intense pressure when the stones are put in of a large size.

Re-examined.—A short time would take off the angularity of the corrugations. The machine could act with the fulcrum at the bottom, but I prefer it at the top.

Mr. Thomas Greenwood, C.E.—The plaintiffs' machine cracks or breaks the stones. It does not pulverize them. The prior specifications produced describe grinding, not crushing machines. None of them present to a mechanic the idea of the plaintiffs' machine.

Cross-examined.—The plaintiffs' machine does not pulverize to dust, but reduces the material put in to smaller dimensions.

Mr. John W. Bird, manager of the Groby Granite Quarries, Leicester, has seen plaintiffs' machine in use. It works well, and breaks very hard stones.

Mr. Manisty, Q.C., then opened the case for the defendants. The following witnesses were called:—

Mr. William Spence, Consulting Engineer and Patent Agent.—In Richards & Grose's specification the points of correspondence with plaintiffs' are, fixed what may be called "jaw," concave and adjustable, to suit different sizes of products of the machine; there is also in both a convergent space downwards, and the surfaces are corrugated horizontally. (The witness' attention was here called to Collyer's specification, but on the vice-chancellor intimating an opinion that it was too vague to be relied on, the defendants' counsel did not press the question, and abandoned that specification as an instance of prior publication.) The witness then stated to the effect that in Hamilton's specification means are indicated for leaving a space at the bottom for the issue of portions of stone broken, but not pulverized; and also an arrangement is shown by which a to and fro motion might be had, analogous to the motion of a movable jaw towards a fixed one. Plaintiffs' machine results necessarily in a crushing operation, there being no blow on the material. I look upon the defendant's machine as a double system of hammers. The blow given by the advancing hammer on the angular-shaped anvil which is opposite to each hammer, causes a split to take place in the stone. The material is held by one set of pieces while the other advances to give the blow. The essential difference between the machines of plaintiffs and defendants is, that in one case the area of the span between the jaws is altered by the action of the movable jaw, and in the other that while there is this striking action of half the number of hammers, there is a corresponding retreat to prevent an undue amount of crushing. I see in defendants' machine a sort of reduction to machinery of the workman's hammer. The resistance of the material is offered to the whole surface of the movable jaw in plaintiffs' machine, but only to half the surface in that of defendants.' That I understand to be a substantial difference. The difference between supporting the fulcrum of the jaw at the bottom and suspending it at the top, is a substantial difference. In the former case there would be less power when most is required for breaking the larger stones.

Cross-examined.—By "crushing" I mean irregular pressure in all directions, and so knocking off fragments in all forms. Defendants' machine would have a crushing effect in some degree. The witness was further cross-examined with a view to show that the action of the parts of the defendants' machine was in no degree analogous to that of a hammer worked by hand. The defendants' machine cracks the stones into pieces. Plaintiffs' machine does this and something more in addition.

Re-examined.—The arrangements in the defendants' machine would, I think, break the stones differently from the surfaces brought together as in the plaintiffs' machine. You would get more of uniform cubically-shaped pieces as the result. If you were reducing for the purpose of pulverizing, the more crushing and smashing the better.

Mr. Thomas Archer, one of the defendants, was then examined. The hand breaking is the best mode of breaking stones for macadamizing purposes, because by hand breaking the stone is split, and cubical pieces generally are produced. No machine approximates so much as defendants' machine to breaking stones by hand. In defendants' machine there are vertical cleavers, not jaws. One series advances, and the other recedes; and the stones being split between these cleavers and the opposite point on the jaw, fall down freely in the open space left by the receding cleavers. There is great difference between the cleaving action of defendants' machine and the crushing action produced by that of the plaintiffs. Stones broken in defendants' machine are more cubical than in plaintiffs' machine, and there is considerably less waste. The alteration made by plaintiffs in the application of the power to the machine is a very material alteration, and improves the action of the machine.

Mr. George Burt stated that he was a member of the firm of Mowlem, Freeman, & Burt, of Millbank. Defendants' machine approaches nearest of all machines he had seen, to the principle of breaking stones by hand. Had seen the plaintiffs' machine, as originally patented, at work in Worcestershire. It would not do for breaking stones for roads; it pulverized too much.

Cross-examined.—Did not know there were two of plaintiffs' machines working at the quarry in Worcestershire. Was only there on a visit for an hour or an hour and a half. Did not know whether the plaintiffs' machine is working there now. Had never seen defendants' machine used for breaking stones for road making. He had sent material to defendants' works, and had it returned broken, and was struck with the manner in which they were broken.

Mr. Charles H. B. Hamlin, manager of the Mount Sorrel Granite Company's Works.—Had never seen defendants' machine used. The result of its working appeared to be a stone more cubical than that produced by plaintiffs' machine, with less dust. Has two of plaintiff's machines at the quarries. Since the pointed tooth has been introduced they do not make so much dust as before, and break the stones more cubically. Had ordered one of defendants' machines, but the delivery was stopped by these proceedings.

To the Vice-Chancellor.—Had been content to work plaintiffs' machine. Has two at work now; used them for breaking stones for roads, before the improvements were made.

Mr. Walter Robert Konipple.—The difference between plaintiffs' and defendants' machines is, that in one the whole of the face of the jaws comes in contact at the same time, and in the other the knives or cleavers are not in contact at the same time. Fifty per cent. are forwards, and fifty per cent. are drawn into the rear. There is no advantage to be gained by the corrugations, as shown in plaintiffs' drawing, over a blunt face. As there shown, they could be no help to break the stone. Had never seen defendants' machine at work.

To the Vice-Chancellor.—The breadth of the knives or cleavers is about 2 inches in defendants' machine.

Mr. Manisty then summed up the case for the defendants.

The Vice-Chancellor, without calling on the plaintiffs' counsel to reply, gave judgment as follows:—It appears to me that this is a case in which it is very important we should fix our attention to what is before us, and in which we should fix our attention to what is the issue; because a great deal of confusion would arise in the case if I were to allow my mind to be influenced by observations made, in the first place, about the application of the pressure from above, instead of the application of the pressure from below; or by what has been said about the crushing and pulverizing; or by this alleged inutility of the patent, supposing it to be made in the manner specified. I will take that last point first. Now, if it was intended to say the instrument made as described in the patent could not be usefully applied to any one of the purposes mentioned; if it is meant to say it is one

to which inutility can be pleaded, inutility should be pleaded and mentioned in the issue, and the plaintiff would have known what he was required to meet. Fortunately for him, our attention was called to it, and fortunately the witnesses state sufficient to prevent a nonsuit. Mr. Marsden was called, and he said it was used in America as described in the patent, and it was so used for preparing stones for metalling roads in the United States, and he had made some of the best roads there that had ever been made; and he was not asked one single question in cross-examination on the subject, which might be well accounted for when the issue of inutility has not been raised. And the case really does not rest there, because in the cross-examination of the defendants' witnesses—and I have not one word of observation to make as to the way in which the evidence was delivered—but the gentleman from the Aberdeen quarry, Mr. Hamlin, says distinctly that the plaintiffs' machines are better now, which I will consider presently; that complaints were made, some time in this year I think it was, but the plaintiffs' machines are made better now; and therefore it was I purposely asked him, "Had you employed the instrument furnished you by the plaintiffs before it was amended in this manner, before it had these sharp lines, or whatever you are pleased to call them, applied to it? Did you before that time use the instrument which had been furnished to you by the plaintiffs for crushing or breaking stones? did you employ the stones you so broke by the plaintiffs' first machines furnished to you in road making before these improvements took place?" and he says, "In great quantities." Here is a gentleman who furnishes great quantities for the purpose of metalling roads (articles which would be rejected by his customers if not adequate for their purpose), and supplied by the plaintiffs' machine, made according to the specification. I say there is not a tittle of evidence to show that, until he took this machine and changed the corrugation, it was useless. Something was said about changing the place where he got the power. That is utterly irrelevant to the matter in issue. He would be entitled to apply power in the best manner he could. It would be pertinent, and very pertinent, if you had raised the question of inutility, and said, "Unless you had something which would put your power below, instead of putting it above, or if you had not had such a modification, the whole thing would be utterly useless." But nothing of the sort has been raised. Therefore, on the one hand, I have the evidence of this gentleman himself, who did make this machine as was described, and that they were used in America for breaking stones; and I have this evidence of Mr. Hamlin, who says that it was not so good as it ought to be, but it was good enough to break stones in larger quantities than had been done by the machines in use before the time when the instruments were made sharper. Then let us come to consider the other question, and see what it is that is claimed by the plaintiffs, and whether the defendants have infringed that which is claimed; because it will not do for the defendants to say, "Mine is a much better machine than yours." That cannot be. It may be a great improvement on the plaintiffs', but you cannot improve upon a patent whilst that patent is in existence; you may take out your patent for the improvement, but you cannot use your patent for the improvement until the original patent has expired. Therefore it must be shown the improvement is perfectly legitimate, and a great struggle has been made to do that. He should say, "My improvement is of such a character as to make it totally different from the plaintiffs' patent." Then, if that be so, if there be that species of difference, it is no longer an infringement, but may be treated as the subject matter of a patent.

Now let us see what the plaintiff claims. It is put here more clearly than in most cases that have come before me. He says, "The invention relates to a peculiar construction, arrangement, and combination of mechanism, to be driven by steam or other power, for breaking or crushing stones for road, metal." I see that between the words "road" and "metal" there is a comma: nobody has ever attempted to say that he intended his machine to break metals. Then he goes on —"for breaking or crushing stones for road metal, or other hard substances containing minerals." Now it is said if you stop there, that "combination of mechanism" might contain all that was afterwards described. It might include all this question of leverage, because it is "mechanism to be driven by steam-power;" and you might include under the term "mechanism," unless there was something to restrain it afterwards, everything until you got to the steam machine to set it in motion. That would include leverage, and everything connected with it. But the patentee says, "this apparatus." I read "this apparatus" to mean the same thing as that which he has described before as "combination of mechanism," he calling it here "apparatus." He tells you it consists essentially of that; therefore he tells you this thing constitutes my patent. "It consists essentially of a pair of vertical jaws, the one being fixed and the other movable, or, if found desirable, both jaws may be movable. These jaws have their active faces corrugated vertically, and such active faces are made also convergent downwards." That enables him to escape from a difficulty that he might otherwise be in. Having said "vertical," some people might say it is vertical and not horizontal, but they are not parallel, they are made convergent—"convergent downwards, one towards the other, so that whilst the space between them at the top, where the stones or other hard substances are introduced, is sufficiently large to receive them in an unbroken state, the space between the jaws at the bottom is only sufficiently large to allow the fragments to pass through after they have been crushed or broken to a required size." Then he says this—there is the apparatus, and the apparatus seems to me therefore to consist of the two jaws put convergently towards each other; but as regards the difference between horizontal and vertical, he says, "I put the jaws with their faces vertically, not horizontally, convergent towards each other, and having the sides corrugated," that is to say, having wrinkles, which are also to be vertical lines, and to run parallel with the plane of the thing itself. Then he says, further, "A short but powerful vibration is imparted to one or both jaws by any convenient arrangement and combination of powerful levers worked by a crank or eccentric on the main shaft." Therefore he claims in no way whatever any special combination of powerful leverage, but he claims only that this apparatus consists of these jaws, fabricated as described, and placed as described, slightly inclined to each other, corrugated, and made to vibrate. There is his apparatus. Then he goes on to say what he prefers his apparatus should be; that is, "one movable jaw," and so on. Then he goes on to show his preference, but his preference has nothing to do with the invention. Other people may prefer something else, and for all I know this gentlemen, the defendant, may have put the leverage otherwise—at the lower part instead of the higher part, and it might have been thought to be a better place; but his invention consists of those two things of combined mechanism; one is, each jaw inclined towards the other, and each of them being made movable if you think fit; but he says afterwards he prefers the *one* being movable, and there being a larger space at the top and greater inclination than there is at the bottom, and there being a slight corrugation and the space below which enables the things to pass through. I ought to mention that he says, it is only sufficiently large to allow the fragments to pass through after they have been crushed or broken to the required size. To my mind that is the whole thing, and nothing more.

Now a great deal has been said about crushing and breaking, and so on, and I thought it was with the intention of bringing it within a patent for pulverization. I was obliged to interfere there. I did not wish to interpose when there were leading questions put to the witness for the mere purpose of shortening the matter; but when Mr. Aston was asking about bringing it to powder and to pulverization "as the plaintiffs do," I was obliged to interfere. There is nothing in the specification about reducing the thing to powder: he talks about its being crushed no doubt, but not pulverized. He talks about breaking it into fragments, and leaving a space at the bottom just the size that you intend; but he does not talk of pulverization, and nobody would think of leaving such a space if it is to pulverize stone.

Now, one is rather timid of fixing a sense to words; but as to pulverization, I think, if I may be allowed to say so, that the former patents were mere grinding patents, that is, for machines for the purpose of reducing things to powder. That is what I should say if you wanted to prove he had been anticipated. This shaking and crushing, and pressing things together, and pressing them with alternate action with considerable force, may be called "crushing," or "breaking," or whatever you please, and you must crush so as to break, and nobody doubts the plaintiff did crush so as to break, but not so as to make powder. He did make powder no doubt in crushing. Nobody can see a man breaking stones in the road, I think, without observing that he makes powder, but not quite so much as produced in the plaintiff's machine. But I say the product which he wishes to get—that is, the stones for making the road—I have it on the evidence he has obtained. That is what he meant to get.

Now, the definition of the word pulverize leads us to the consideration of the distinction between this apparatus and those we have had before. It would be preposterous to say, when you come to examine those patents, that any of them were practical; and we have no evidence to show that any of them were practical, or that any of them were put into use whatever. Whatever they were, they were of a totally different character and description from anything which the plaintiff devised. The first you have is Hamilton's patent, which was simply to roll it—more like a pestle and mortar than anything else. It was to grind by means of a sort of globular pestle working in a mortar, the sides of which, of course, do not fit closely to the pestle. It was a kind of ball, which was placed in a thing like a mortar, getting wider as it got to the top; and I was a little surprised at one of the witnesses calling it a sort of jar which the pestle was to move in.

Wishing to bring it to the plaintiff's description he called it a sort of jar, in which the pestle was to move and in which the thing was to be ground. Then another gentleman had a provisional specification, but Mr. Manisty very properly abandoned that as being too wide, because that might have described anything else in the world. That was the specification of Collyer. Then came the third thing, which had a very remote, an exceedingly remote approximation to the plaintiff's specification, but which provided not only for grinding, but did leave a power of escape to the broken pieces by means of lifting up the pestle, a kind of club more like a pestle than anything else, which moved in a basin to and fro. If you chose to raise the pestle, which was a thing of great weight and great power, and which the patentee supposed you might have raised, then you get a larger space for the exit of the material which you have in it, and the question is whether that describes any such thing as the plaintiff has described, or would do the work the plaintiff's would do, of which I have not a word of evidence, which was exactly like Dobbs' patent so much discussed in the House of Lords. But besides that, I apprehend that even if the machine had actually been worked, it was totally different from the plaintiff's; because the great part of the operation of the machine was for grinding to powder, whereas this of the plaintiff was simply by a mere cracking of the jaws, as Mr. Manisty wants to put it, like nut-cracking. It is not a process of pressure like nut-cracking. You are to crack the fragments, and you are to let the materials drop out of this pair of jaws. It seems to me that is the whole description, and I must say I never heard of anybody who ever saw anything like it.

After some observations on a conflict in the evidence not materially affecting the issues to be tried his Honour continued:—Then as to the defendant's process, I will concede to him, and I do not deny that he has brought great strength of evidence, especially Mr. Burt's evidence, to show that it is a useful machine. He has never seen the plaintiff's machine at work, but he has seen it; but he thinks the defendant's process an improvement, as to utility that was questioned by Mr. Marsden, who said the defendant's plan would destroy the machine and make it utterly useless. I have not any satisfactory evidence as to whether Mr. Burt's goods were furnished by the defendant's machine or not, but assuming it to be so, and assuming the defendant's machine is an improvement upon it, still, is it not the identical thing improved? That is the thing. Has not that got everything that is essential? It has got the one jaw certainly, the vertical jaw. It has got on the other side that which instead of being one jaw, is a piece of metal split into different parts, but each of them of considerable breadth, two inches at the part where they press, and he corrugates the iron on the one side and on the other vertically, not horizontally, as in those prior patents. He enlarges them in that manner, and he brings pressure upon one-half of his plate. That is really what it comes to. He has a plate which he divides into ten parts if you like, and he brings five parts of that plate forward against the opposite side, and when the work is done it drops through as in the plaintiff's process, and you have a moving plate moving to and fro, pressing against another plate which is corrugated. You have the aperture made as wide as you like at the bottom to let the fragments drop out as much as you like; and what the defendant says he has done is this, he has divided the plates into several plates, all pushing against the opposite plate, one half of them pushing

at one time, and the other half of them pushing at another time. One of the gentlemen of eminence says, 'One appeals to one's own common sense in the matter,' and Mr. Manisty also has appealed to one's common sense. With regard to myself, I am unwilling to trust to it, I confess; but it does appear to me that each portion of the plate, namely, the five portions which are made to work in an alternate manner with the other five, that each portion when pressing is a vertical plate pressing against the opposite vertical plate, and it acts so as to crush and to break.

Now, as to the importance of this word "crushing," because the last witness took quite a different view of it. He described the instruments as two knives, and as performing the process of hammering. Mr. Grove successfully cross-examined that witness as to the process of hammering, to show that there was no sharp impact, and that there was no weight on the hammer. There is nothing like hammering, and there is no great weight of the hammer which produces momentum. The whole thing is pushed horizontally by the power of a lever, by the lever being put at the bottom instead of the top, and there is a shove of those five plates across to the others. As to knives, there is nothing like a knife. These are five blunt things. You might as well talk of having your leg cut off when it is jammed off by these things, instead of having it cut off with a sharp knive, as in a surgical operation. It is a different thing altogether from a cutting action. This is for breaking heavy granite substances, quartz, and other materials, and how can it be called a cutting action at all? You have ridges of pressing surfaces, and you have these intervening gaps. That may be an improvement, or not; I cannot pronounce as to that, it is not before me. At all events, you have taken what is the principal part of the plaintiff's invention; you have taken his vertical plate, and that which is opposite to it; you have taken the other plate which presses against the vertical plate; you have taken the other plate which presses against the corrugated plate; and, having done that, you may have found out sharp corrugations, not exactly "teeth," as Mr. Manisty said, but sharp ridges, sharper ridges than the plaintiff has pointed out, to enable his machine to break or squeeze the substances easily by pressing one iron against the other; but you have made sharper corrugations, and you have left spaces in which you have enabled the things to drop through better than the plaintiff has: but after all you have every ingredient of the plaintiff's, you have the application of his apparatus; and his combined apparatus I hold to be the simple plate inclining downwards, moving towards the one opposite, that other plate receding; this oscillating motion, and the material being poured into the aperture at the top, like that of a funnel, which is broader at the top than at the bottom. It is more like an inverted tent with a space down below, through which the material can be made to drop, and that not pulverized, but according to the size you wish to have it. It appears to me, if I have correctly described the defendant's invention, he has every single element of the plaintiff's patent, and has something also which the defendant's witnesses think an improvement, and which I am perfectly ready and willing to concede to be an improvement; but he cannot use it till the plaintiff's patent has expired, and, therefore, I must find in that form for the plaintiff on all the issues.

November 20.—The cause now came on for hearing, when the vice-chancellor made a decree for an injunction to restrain the infringement of the patent by the defendants, with the usual account of machines made or sold by defendants, and an inquiry as to the damages sustained by the plaintiffs by reason of the acts of the defendants; the defendants to pay the costs of the suit. His Honour also ordered the defendants to make an affidavit as to the number of machines in their possession, with a view to such machines being marked so as to prevent their being used at any future time in any infringement of the patent.

REVIEWS OF NEW BOOKS.

MODERN MARINE ENGINEERING ILLUSTRATED. By N. P. BURGH, Engineer. 1 vol. royal 4to, with thirty-six coloured plates and 240 woodcuts. Spon, London. 1867.

THIS is, taken for all in all, a capital book, the *best*, we are almost disposed to say, in existence in English at the present moment upon that highly important branch of engine making, viz., marine engineering. It is a thoroughly practical book, and by a gentleman who is very obviously a practician of a high class, though probably by no means a high-class theoretician. In several ways thus it is a characteristically English book. The author has been able to collect working drawings of almost all the important types of British marine engines, large and small, from nearly all our great or meritorious makers. These are given in his thirty-six large, folding, coloured lithographed plates, in a style which does great credit to his publisher. The plates appear to have been printed in black outline, with cross shaded sections of solid parts (from the working drawings) in the first instance, and then the colour tints printed over this. We have never seen what the lithographer calls "the register," *i.e.*, the coincidence of boundary lines in such plates, so perfectly kept before, nor the tints in any English colour plates so judicious and agreeable. These plates are genuine sources of information, not only to the student or mechanician pupil, but to each of our great makers as to what his rivals do and deem best; and they are all what they profess to be, modern instances taken from the practice of the present time.

The worst part of the book, and indeed the only part to which we make the smallest objection, consists in the first thirty-one pages of what the author has somewhat oddly called "prefatorial matter." This appears to be intended for a sort of generalized history of steam and steam-navigation apparatus, interwoven with critical matter in relation to the different classes of engines and propellors, *concluding* with heat and combustion. We must confess, however, that very much of it beats us altogether in comprehension, but as was said (with little truth) in another case,

"When Berkeley said there was no matter,
'Twas no matter what he said:"

so we may absolve Mr. Burgh's "prefatorial matter" from being of much matter either in the way of illustration or blemish, to the remainder of his excellent work.

This matter "prefatorial" is, however, a curiosity; here is an example of matter and style. The subject is anent heat and combustion, &c., p. 23:—

"The flame acting on the surface of the metal (of the boiler namely) disturbs the fibre of the same, and until the process of annealing can be said to have been partially completed, the destructive properties of the gases are in continual operation. Now with reference to the amount or depth of fluid surrounding the plate. Much depends upon the evaporative properties of the latter; in fact it is not saying too much to assert that the chemical nature of the materials used, either solid or fluid, should have liberal attention. In all phases of science an appeal to the origin or natural state of the cause and effect of the branch investigated, will give a truthful result. The natural adherent faculties of all materials are worthy of the greatest consideration; also the alteration of the same while under the artificial process of manufacture.

"The ore, in its state of purity, is a composition of certain minerals; the cupola and blast separate the same, and metal in its primary grade is the result. The next stage is purification or the production of adhesion and elasticity, adherent, or rather combined. The third operation is the particular manufacture for practical utility, and the completion the application of the material. This is the category actual of the boiler plate, and to correctly apply the same is to understand the nature of the produce. To the present, iron has only been alluded to as the material available for marine boilers. There are, however, other metals equally, if not better, conductors of heat, and more durable than that already mentioned.

"The resistable nature of all metals consists of three kinds—torsion, tenacity or adhesion, and compression or crushing strain. From these three natural causes are produced many effects. With torsion, a distorting tensile strain may be said to be resisted; with a tenacious nature, ductility of material is available, and with cohesion; compression or crushing, a total disturbance of the fibre, or a natural disposition of the section and external surfaces is imperative to produce the same. The elasticity of any material must not be confused with the ductile properties of the same. Both natural effects do not emanate from the same cause; india-rubber is certainly the most elastic of all solids, but ductility is its least availability for practical purposes. The metals most utile for conductors of temperature are silver and copper. The former from its scarcity and non-resistance to tensile strains practically, is more ornamental than useful. The latter metal is better adapted for practical purposes, being stronger and more plentiful. Ductility of metal, in the practical sense of the term, means a suitable resistance to tensile strains while being altered or extended in shape uniformly. Adhesion is another faculty which all ductile materials possess; hence copper may be truthfully said to be the best conductor of heat for practical purposes. For fire-boxes the material now advocated has been found long ago to supersede all other metals, not only from its powers as a conductor, but from its natural availability for manufacture without jointing. This advantage can be readily appreciated when it is remembered that all joints of plates are the weak parts, and bad conductors at the same time. Heat penetrates through bodies disproportionately, due of course to their fibre and nature. Deal, or flannel, or felt, may be said to be the retainers of temperature. Flannel will preserve ice, and the same effect is gained by clothing steam pipes. The lagging of boilers is deemed one of the adherents in order to economize the heat; further allusion to this will be given, *per se*, in the mechanical section of this work."

And so on, to the end of these "prefatorial remarks," which, if they be the "words of the wise," are beyond question "dark sayings."

In a word, as these first thirty-one pages prove that the author has but the wildest and most unordered notions of abstract science, and the most extraordinary and idiosyncratic glimmerings as to the meanings

of English words and their construction into sentences, so do the succeeding eight capital chapters, which constitute the real pith and marrow of his book, prove that he is right well acquainted with the practice of marine engineering, and that he has a clear head for the conception and description of mechanical details, and a sound mechanic's judgment in the choice and criticism of the methods and organs to be employed in constructing the marine engine.

In these eight chapters Mr. Burgh deals first with the several main distinct types of marine engine as a whole, illustrating these by wood-cuts, plans, and elevations, &c., of examples by our best makers. He then proceeds to the organs or parts of marine engines in detail, and describes, if not all, yet all that is of most value, as found in the finally deduced and acted upon practice of all the great British engine shops.

We should not exaggerate the merit of these parts of this work were we to be somewhat lavish in praise. Whilever in these comprehensive and beautifully illustrated chapters the author sticks to "the thing done," to the actual practice and *result of the workshop*, he is clear and full of teaching power; but the moment he gets back, as here and there he does, into theoretical notions he becomes transcendental, and now and then grotesque. Thus (p. 113, Action of the Flame on the tube plate): —"The flame does not *voluntarily* act on the tube plate, it is *impelled towards* the same. Now the natural flow of gases, as before stated, is curvous, and therefore the form of the flame between the tubes will be due to that law." The italics are the author's, not ours. Again (p. 135):—"Now the natural direction of caloric is to ascend, and when the flame was passing through the tubes, the penetration of the heat was therefore the most available." We might pick out a good many more of these extraordinary bits of composition, but we have no wish to do so; for, notwithstanding these to the contrary, the might and mass of the book is good, sensible, and sound.

Chapter 9th is all that treats of the *science* of proportioning the parts of marine boilers and engines, and this it does briefly, and rather by the recapitulation of rules and diagram methods than by any appeal to principles at all. In this chapter there are some things that the already well-educated mechanician will find useful, and perhaps new to some. But this chapter, as indeed the whole work, is better fitted for the man who has already acquired his stock of fundamental and rudimentary mechanical education and knowledge elsewhere, than to the mere student or learner.

The very same defects of sound fundamental abstract technical education, which this work itself proves belong to its author, in common more or less with nearly every engineer and mechanic in Great Britain, are such as prevent its real merits in practical details from becoming of value, except to the previously soundly educated student. He can gather the thick-spread grains of wheat with which the volume is full, and recognize the chaff where it occurs. It is for this precise reason, for this remarkable combination which it presents of practical knowledge, judgment, and ability, with defective theoretic knowledge, in a word, want of scientific technical education on the part of its author, that we have said at the commencement of it that it was characteristically an English work—a work indicating our national supremacy in practice with our deficiency in science to direct or to extend that. And this is just the "why" we in Great Britain are being run up to, and are but too likely to be passed, in the race of mechanical progress by the Continental nations.

Let any one compare, for example, the we may say *pendent* work in French by M. Ledieu on marine engines with this of Mr. Burgh, and he will have a clearer notion, if he need such, of what we mean. There he will find the enunciation of *principles* begins the book; these are given in order, clearly, rigid and precise, and with a free use of symbols and formulæ; the author rightly assuming that the student of his book will have acquired at some *Lycée*, or higher school in France, the preliminary knowledge of all needful branches of science that shall enable him freely and easily to use such methods.

We hope, for the sake of the public, as well as of the author and publisher, that his work on the marine engine may require a second edition. Should it do so, we would venture to counsel his cancelling all his "prefatorial matter," and getting some friend to join to his aid by translating, with permission, the necessary portions of M. Ledieu's work from the French, and letting that form the theoretic and introductory chapters. With such a commencement, followed by Mr. Burgh's eight chapters of practical detail, the organology of the marine engine, as we may call it, and the admirable plates, a work might be produced which is needed in English, and which might take a higher position than any existing work on the marine engine in our language.—Ed.

A Lecture on the Sewage Difficulty. By Baldwin Latham, C.E. Delivered before the Board of Health, Maidenhead. Pamphlet, 8vo. Spon, London. 1867.

This pamphlet is somewhat of a controversial character, being *in reply* to a paper by Mr. J. D. M. Pearce, M.A. Its drift is to uphold the importance and value, even commercially, of the system of getting rid of sewage by irrigation upon the land, as the means of at once avoiding the perils of cesspools, even upon their improved and gigantic construction, as in Paris, and the pollution of our rivers and streams. It does not appear to add anything to our previous knowledge, and was rather intended to enforce the author's views as to a still vexed question upon a local board with which he appears to be professionally connected.

Engineering Facts and Figures for 1866. Fullarton, Edinburgh and London. 1867.

Of this annual volume it is enough to say, that it is as good as the last which preceded it, and is on the whole a well executed selection from the more or less new matter that has appeared in technical journals; but it is miserably deficient of what is really needed yet by the British engineer and mechanician. It is rather what is new in *foreign* journals, which are to him generally sealed books. than what he may find in the periodicals on his own table, that he wants.

FOREIGN LITERATURE.

Organ fur die Fortschritte des Eisenbahnwesens in Technischer Beziehung. Von E. Heusinger von Waldegg. Neue Folge, 4 Band. 1867. Kreidel, Wiesbaden.

We have just received the last instalment of this invaluable technical work, and it fully keeps up the promise it showed at its commencement, of being not only the most complete, but what is of more value, the most truthful current record of all that is doing in the general improvement of the rail machineries of the several railway systems of the world. It is the work which should stand foremost as a text-book in the library of every railway or locomotive engineer especially.

The editor is evidently a man completely *au courant* with all that is doing in railway progress. It is a sad fact that no such work exists in the English language, and it is probably still more to be regretted that so few English engineers are capable of reading those under notice, from the mere fact of ignorance of the language in which it is written.

Now that it is too late we begin to regret, but we have indeed much to learn from the business-like, systematic, and unmixed manner in which the Germans produce their technical publications; whereas at home, through being rooted in an old-fashioned and jack-of-all-trades custom, our best technical periodicals are more or less but mere scraps of information, useful enough in their way, but often huddled together without discrimination or system. Shall we ever alter? It is fully time, or it may ere very long prove too late, when our rising generation are beaten in the race of systematic technical education; and we hold that our professional literature should have no other aim but the downright genuine teaching of its readers, especially too when we recognize the fact, that from it must be principally culled much of that special information which our *élèves* should be provided with.

If such a work as the present were initiated in our country it is certain that it would be widely prized; we should indeed be glad to see this German production translated into our tongue, and predict a successful issue to it. Altogether it is an exhibition of that peculiarly orderly and intellectual manner which the Germans appear to possess of putting their literature together, as well as showing the best style of printing, to which we may add that the lithographic plates are even superior to many of the plate engravings at home—V.D.

Zur Warmelehre von Standpunkte der Emanations Theorie. Von Nicholaus Radadowitsets. One vol. 8vo. Figs. in Text. Göttingen. 1867.

We notice this work for the benefit of the few of our readers whose science is at the sufficient high-water mark to enable them to swim in

its depths. It is the heat and motion theory viewed by the aid of a new hypothesis; one, however, which is in truth not quite so new after all. The heat and motion theory has much yet to do before it shall have got to that position, which it will yet one day occupy, when it will form the base on which all the applied science of motors in common will rest, whether these are to result in work, or heat, or light, or electricity, or any two or more of these interconvertably; when, in fact, it shall have become the engineer's and mechanic's guide. As yet, it is scarcely comeatable by more than the man of exact sciences, and of these but a few.

DIE THEORETISCH BESTE CURVE FUR DER SPITZE DER GESCHOSSE. UND SCHIFFE. Von GUS. F. VON LAMEZAN, Ober. Lieut. der Artillerie.

THIS is a new attempt to ascertain the conditions of a solid of least resistance for the advancing end either of elongated projectiles or of ships' bows. We cannot say it adds much to previous knowledge, but it is a clear and brief investigation.

THEORIE UND BAU DER ROHRTURBINEN, &c. Von PETER RITTER VON RITTINGER, Ministerialrath in Wien. 1 vol., 8vo. 128 pp., with plates, &c.

THIS is a work with all the elaboration and completeness characteristic of Von Rittinger, in which the general principles of the pipe turbine, or Jonval turbine, with deduced rules and diagrams for its construction, are given. It is too difficult and mathematical for British mechanicians generally. A general work on turbines in English is needed, and an abstract of this might well form a part of such a work.

DIE FORTSCHRITTE DER BERG UND HUTTENMANNISCHEM WISSENSCHAFTEN IN DEN LETZTEN HUNDERT JAHREN. By BEUST, WEISBACH, BREITHAUPT, COTTA, and SCHEERER. Freiberg: Craz & Gerlach. 1867.

THIS volume consists of a series of essays by the above-named distinguished men, delivered upon the occasion of the second centenary jubilee of the establishment of the Royal Saxon School of Mines at Freiberg. The names of the authors alone are a sufficient assurance that nothing commonplace or jejune can be found in their utterances. At the same time we must confess we have been unable to discover anything very novel in the several lines of thought, nor any important and broad views either as to the present or the future of mining operations. What, indeed, can be predicted as to the future of a branch of human industry which, like mining, has existed upon a great scale for at least a thousand years in Europe only, and yet has failed as yet to frame for itself a *science*? one of all others almost the most absolute creature to the present hour of pure empiricism.—ED.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

ROYAL UNITED SERVICE INSTITUTION.

ON THE ECONOMY OF FUEL, COMPRISING MINERAL OILS.

By Professor W. J. MACQUORN RANKINE, C.E., LL.D., F.R.S., &c.

(*Continued from page* 252.)

I HAVE gone at some length into the principles of the total evaporative power of different sorts of fuel, because it is of great practical importance to understand them. They show the theoretical limit towards which practice approaches in the course of improvement, but which practice cannot surpass nor even attain; the knowledge of those principles prevents people, on the one hand, from forming too small an estimate of the results which may be got from the economical use of fuel; and on the other hand, from indulging in exaggerated estimates of those results. It shows us, indeed, what is the actual waste, when we know the result attained in practice; it enables us to judge how far that result falls short of theoretical perfection, and what room there is for further economy by means of improvements.

Now, as to the causes which make the available evaporative power fall short of the total evaporative power.

In the first place, there is imperfect combustion, all the combustible constituents not being combined with the proper quantity of oxygen. This generally arises either from want of a sufficient quantity of air, or from want of a free mixture of air; and in the case of gaseous fuel it sometimes arises from sudden cooling, through coming in contact with some cold substance, so as to lower the temperature and extinguish the flame before the combustion is complete. As to the want of a sufficient quantity of air, the remedy is obvious enough. It is to take care that there are openings enough to admit a proper quantity of air. Still we may supply a very large quantity of air yet fail to realize complete combustion, because of the air not being thoroughly mixed with the fuel. I have already referred to what we have to do when we have a draught produced, in a quiet way, so to speak, by the ordinary action of a chimney. There is not sufficient agitation of the air to produce a thorough mixture, unless we introduce a surplus quantity of air. We may produce forcibly a thorough mixture of air with the gaseous fuel by such means as the use of the blast pipe, the steam jet, or the fan. This is one of the chief uses of the blast pipe in locomotive engines. The object of blowing steam jets into the furnace, or, at all events, one of those objects, is to produce the same effect. Although the fuel should be solid coke, a great deal of it is actually burned in the gaseous state; for it first undergoes that sort of half combustion that produces carbonic oxide. That carbonic oxide is a gaseous fuel; and in order to burn it completely we have to make sure that it is thoroughly mixed with air. Then, the complete combustion of fuel that is in the liquid state may be promoted by contrivances that blow it into spray, or convert it into vapour, and in that condition mix it with the air. We may blow it into spray by the impulse of a jet of steam; or by superheating that steam we may at the same time convert the liquid fuel into vapour, and mix that vapour with air.

As to the extinction of the flame by cooling, that is a thing which often takes place in steam-boilers, heated by coal that contains a large proportion of volatile constituents. When first set free and brought in contact with the air, these take fire; but the flame comes in contact with the heating surface of the boiler, which is at a comparatively low temperature; the combustion is checked, and instead of combustion, we have decomposition of the hydrocarbon gas. The carbon and hydrogen are separated—the carbon in the shape of black particles, which form smoke; and both the carbon and the hydrogen go off to a great extent unburnt.

I might here enter into a calculation to show what amount of waste of fuel may arise from an imperfect or ill-managed supply of air. It would perhaps occupy too much time to go into detail; but I may mention a fact which I have already stated in the case of carbon, that if it combines with only half of the quantity of oxygen that it requires for complete combustion, we have only $4\frac{1}{2}$ units of evaporation, instead of 15. The evaporative power is reduced to three-tenths, so that seven-tenths of it are lost.

Then in the case of fuel like bituminous coal, which consists partly of solid carbon, and partly of volatile compounds of carbon and hydrogen, we may have the hydrogen going off imperfectly consumed, either alone, or carrying away more or less unconsumed carbon along with it. From what I have stated respecting how much of the evaporative power of the bituminous coals depends on the carbon, and how much on the hydrogen, it will be understood how much may be lost in different cases: $2\frac{3}{4}$, or in some cases 3 units of evaporation if the hydrogen alone goes off without being consumed; and if it carries off a certain amount of carbon along with it, that waste may be more than doubled.

I have spoken of the remedies for the imperfect combustion of gaseous fuel, by thoroughly mixing it with the air, either by a blast pipe or by a steam jet. As to the thorough combustion of carbon in the solid state, one way to insure that is, by keeping a thin fire, that is to say, having a very large grate in proportion to the quantity of coal to be burned, and burning only a small quantity of coal, say 10 lbs. per hour on a square foot of grate. I have known as little as 4 lbs. per hour burned on a square foot of grate. Thus we may insure that there shall be free access of air to all the burning carbon. But another plan is, to let the combustion on the grate be imperfect, by keeping a thick layer of coal on the grate, which turns into coke, and then to introduce a supply of air above the level of the fuel on the grate, for the purpose of consuming the carbonic oxide and the hydrocarbon gas that are in the gaseous state. There is a known contrivance, called the "dead plate." It is a cast-iron plate at the mouth of the furnace, on which the fresh coal is laid and exposed to a heat sufficient to distil away the volatile constituents. The coal gas so distilled passes over the layer of red-hot coke on the grate; a surplus of air passes through the red-hot coke, sufficient to burn the coal gas. Then, after the coal gas has been all distilled away and burned in that manner, the coke that remains on the dead plate is pushed on to the grate, to be burned in its turn.

In the case, then, of burning coal which is a compound of fixed carbon and volatile hydrocarbon, we have the two plans, of a large grate and a thin bed of fuel, where we have plenty of space; or, of a comparatively small grate and a thick bed of fuel, and introducing air above the fuel to burn the gas, where the space is limited.

There are numerous contrivances for the efficient combustion of coal which cannot now be described in detail, such as the use of a separate combustion-chamber of brick, in which the burning of the whole constituents of the fuel, solid and gaseous, is completed, the chamber being built with double walls of brick, and a double arch of brick over the top, so as to prevent loss by conduction. Another plan is to make what we may call "crude gas," by the imperfect combustion of coal, so as to turn all the combustible constituents into a mixture of coal gas and carbonic oxide, and then to burn that mixed gas. There are also double furnaces, air-valves of various kinds and in various places, and an endless series of other inventions.

So much, then, as to the waste of heat through imperfect combustion, and the means of preventing it.

There is another sort of waste of heat: that is, by conduction and radiation. It was ascertained by Péclet, that about half the heat that comes from coal in a furnace radiates directly from the incandescent fuel, and is not carried by the current of flame, or the hot gas, to distant parts of the heating surface. We must be careful that none of that heat escapes from the furnace. For example, if there are openings in the furnace door to admit air, we must take care that the door at all events is double, with the openings of the inner plate not directly opposite those of the outer plate, so that radiation shall not take place through them. Or, we may have a grating of several plates placed edgewise close together, between which the entering air may pass, and so absorb the heat that has been radiated to those plates. I have already referred to firebrick casings round a combustion chamber, to prevent loss by conduction. The prevention of that sort of loss is a very obvious matter.

I now come to a third mode of waste of heat, which is a highly important one: that is, the waste of heat up the chimney. The products of combustion escape by the chimney at a temperature above that of the external air. Whatsoever heat is expended in raising the temperature of those escaping gases above the temperature

of the external air, is a total loss as regards evaporative power. It is useful for certain purposes. It is useful to rarefy the air in the chimney, and to make it lighter than the air outside, and so to cause the draught of the furnace; but it is not useful as regards evaporative power. The quantity of heat wasted in this way depends upon the specific heat of the burnt gas, which is about one-fourth of that of water; so that for every pound of gas that goes up the chimney, and for every degree of elevation of the temperature of that pound, we have one-fourth of an ordinary unit of heat expended: being in round numbers and for Fahrenheit's scale, about the $\frac{1}{1000}$ part of a unit of evaporation per degree and per pound of burnt gas.

The following formula expresses in a condensed form the waste of heat up the chimney in units of evaporation:—

$$\text{Loss by Chimney} = \frac{1 + A'}{4000} \text{ Tc Fahr.};$$

and the following are examples:—

$1 + A'$,	13	...	19	... 25
Tc,	600	...	600	... 600
Vol. gas, cubic feet,	325	...	475	... 625
Loss of evap. power,	1·95	...	2·85	... 3 75

$1 + A'$ denotes the weight of burnt gas per unit of weight of fuel, and Tc the elevation of the temperature of the chimney, in degrees of Fahrenheit, above that of the external air.

The products of combustion, for the reasons I have already stated, are more or less diluted with additional air; so that in the case of ordinary bituminous coal, $1 + A'$ ranges from 13 to 25, and 19 is an intermediate value. In the case of hydrocarbon oils, the air that is required for oxidation is about 15·3. We have to add the weight of fuel, and we shall get about 16·3 for the net weight of burnt gas; and it is quite possible that in a well-contrived furnace, no surplus air may be necessary. We multiply the weight of burnt gas which goes up the chimney by the elevation of temperature in the chimney, and if that temperature is expressed in degrees of Fahrenheit, we divide by 4000, and the quotient is the evaporative power lost up the chimney.

It is easy to see that in order to diminish that sort of loss, we must in the first place have the temperature of the chimney no higher than is absolutely necessary. When the chimney is the means of producing draught, it can be demonstrated that the most effective draught is produced by a temperature not much above 600° Fahr.

It is still more important to avoid an unnecessarily large supply of air to the fuel. We must supply the quantity of air that will give the oxygen necessary to consume the combustible elements, otherwise we shall have enormous loss from imperfect combustion. Every additional pound of air we supply carries to waste a certain amount of heat. I have said that when we produce the draught by means of the rarefaction of the air in the chimney alone, we require 12 lbs. of air per lb. of fuel for oxidation, and 12 lbs. more for dilution, making altogether double the net quantity of air. If we use the blast pipe as in a locomotive, I think it is quite certain that it is not necessary to supply more than once and a half the net quantity of air, and in some cases we need only supply a mere fraction more than the net quantity. I have very little doubt that in methods of burning mineral oils which I have seen tried, where by the help of a jet of superheated steam, the fuel is thoroughly mixed with the air immediately before the process of combustion, the net quantity of air is sufficient of itself, and we may altogether avoid that very great waste of heat which arises from the supply of an additional quantity of air.

To exemplify the waste of evaporative power that may so arise, I have annexed a few calculations to the formula. I have taken the weight of the gas going up the chimney as first 13 times, then 19 times, then 25 times the weight of the fuel burnt. I have taken the temperature of the chimney as 600° in each case, that being the best temperature when we use chimney draught. In the next line are stated the volumes of gas that go up the chimney in cubic feet per pound of fuel. That, however, is a collateral matter. In the next line is stated the loss of evaporative power due to the escape of that gas. And observe that it is in very favourable circumstances. The temperature of the chimney is no higher than is necessary to produce the best draught, yet in the first column the loss of evaporative power is 1·95; in the second, 2·85; and in the third it is 3·75. Losses much exceeding those are very common.

If the draught is produced by artificial means, such as a steam jet, we do not need rarefaction of the air in the chimney in order to produce a draught. We may have the rarefaction as an auxiliary, but it is not indispensably necessary. In fact, it seems that if we adopt proper means for producing draught by mechanical appliances, we may use such a heating surface as to take up almost all the heat of combustion, and reduce the loss of heat by the chimney to an inappreciable quantity.

I will now say something regarding the results deduced from a comparison of experiments by many authorities upon the effect of extent of heating surface upon the economy of heat. It is through the heating surface that heat is communicated from the flame and hot gases to the water in the boiler. Upon the extent of the surface depends very much the proportion of that heat which is made available. It is not yet possible to lay down any precise theory upon this subject. But the formula I have written down gives, at all events, a good rough approximation to the results of experiment and of practice in a variety of different cases:—

$$\frac{E'}{E} = \frac{bS}{S + aF}$$

Values of a	·5	...	.3, &c.
„ b	1·0	... ·93	... ·9, &c.

It is based upon principles of this kind—that whatsoever parts of the heating surface are nearer to the fire, take proportionally the greater shares of the heat, and that each additional area more and more distant from the fire takes proportionally less and less heat. Suppose a certain area of heating surface in immediate contact with the furnace: it will absorb a certain quantity of heat. Then, the next area of equal extent beyond that will absorb a much less quantity of heat; and so on, each successive additional area absorbing a less and less quantity until at length it becomes no longer practically advantageous to increase the area of the heating surface.

By comparison of a good many experiments and a good many results of practical experience, we have this approximation to the proportions of the available to the total evaporative power of fuel, as depending upon heating surface. Let S denote the number of square feet area of heating surface, and let F denote the number of pounds of fuel burned per hour; let a and b be co-efficients to be deduced from experience. We multiply the area of heating surface by the co-efficient b, and we divide by the area of heating surface, plus the number of pounds of fuel burned per hour, multiplied by another co-efficient a. From the practical results to which I have referred, it would seem that the value of the co-efficient a, upon which the waste of heat mainly depends, ranges between 0·5 and 0·3. It is 0·5 for a chimney draught, and it is 0·3 for the draught produced by a blast pipe or jet of steam. This 0·3 is found as the result of the use of the blast pipe in locomotives. And it would seem that the co-efficient a is very nearly proportional to the square of the ratio of the total weight of burnt gas to the weight of fuel; so that if we double the quantity of burnt gas per pound of fuel, we shall quadruple this co-efficient a; if we can reduce the quantity of gas per pound of fuel to one-half, we shall reduce the co-efficient a to one-fourth. As to the value of b, it comes very near to unity in some cases, in which care has been taken to make the motion of the water in the boiler take place in the most advantageous direction, relatively to the motion of the products of combustion, that is to say, in the reverse direction —to introduce the feed water in contact with the coolest part of the heating surface, and let it advance gradually to the hottest part, where it is finally converted into steam. That principle was carefully attended to in the boiler invented by Lord Dundonald. If that precaution is neglected, we may lose from 8 per cent. to 10 per cent. of efficiency. But the diminution of efficiency depends mainly upon the waste of heat up the chimney, which is brought into the formula and provided for by the co-efficient marked a.

Here is an example of a particular case:—

$$\text{Let } \frac{S}{F} = 1;\ a = \cdot5;\ b = \cdot9;\ \text{then } \frac{E'}{E} = \cdot6.$$

We will suppose that we have one foot of heating surface for each pound of fuel burned per hour: then S divided by F is equal to 1; that we use a well managed chimney draught, so as to have a equal to 0·5; that we do not pay particular attention to the place where we introduce the feed-water, and do not use a feed-water heater; so that we get b equal to 0·9. Then, by introducing those values into the formula we get for the efficiency, or proportion of the total evaporative power to the available evaporative power, 0·6. This is a very common case in practice, and when it is realized it is considered a very good result. If we have a specimen of coal whose total or theoretical evaporative power is 15, and we get 6 per cent. of that, and its actual or available evaporative power is 9, that is regarded as a good performance. You see how that arises—how step by step such a result is arrived at upon scientific principles.

I may observe that the actual efficiency of furnaces—the proportions of the available to the total evaporative power of fuel—go through a very wide range. We find cases in which there is only 45 or 50 per cent. of the total evaporative power actually realized, or made available, and yet these are not considered very bad. From 55 to 60 per cent. are ordinary results, in good marine boilers. When we get above those we get to results that are rather uncommon, and when we get to 80 or 90 per cent. being realized, it is considered very extraordinary.

In conclusion, I make the following observations on what we may look forward to as the probable result of the introduction of such classes of fuel as mineral oil as substitutes for coal. Coal is a very complex kind of fuel. To insure the best possible economy in the use of it requires the fulfilment of many different conditions, some of which conflict with each other. We have to burn fixed carbon, and we have to burn the gas that is disengaged from the coal. We may burn one very efficiently, and not burn the other. It is extremely difficult to manage the introduction of air, so that there shall at once be no risk of deficiency of air, which causes imperfect combustion, and gives bad economy in one way; or a surplus of air, which carries heat to waste up the chimney, and causes bad economy in another way. On the one hand we are exposed to the risk, from any little fault of construction or management of the furnaces, of the hydrogen going off unburned, and of its carrying off a large portion of the carbon unburned also. On the other hand we are exposed to the risk of solid carbon being imperfectly burned, and going off as carbonic oxide. The contrivances for diminishing the causes of waste are somewhat difficult and complex to apply in practice; and above all, too much depends upon the skill of the fireman or stoker. We may almost say everything depends upon the way the furnace is managed. The very best furnaces, the very best boilers that were ever contrived, may be made extremely wasteful by a careless stoker. On the the other hand, in using mineral oils, we are somewhat in the position of the chemist who has got a good burner for burning coal gas. We have to contrive a suitable apparatus for introducing that oil into the furnace in such a way that it shall be thoroughly mixed with air—whether in the state of vapour, or in the state of fine spray, with or without the assistance of some porous substance to act as a wick. A steam jet seems to be the most efficient apparatus for that purpose. Then if our apparatus is properly contrived and properly constructed, and works in the right manner and produces complete combustion at first, there is no reason to suppose that it will ever act badly if treated with ordinary care.

It would seem to be no difficult matter with fuel of that sort to diminish the waste of heat through imperfect combustion to nothing, and the waste of heat through hot gases going up the chimney to something very small indeed. In fact, such an efficiency as 90 per cent. of the total evaporative power being realized, instead of being a very extraordinary thing, may be looked for as a very ordinary thing; so that, taking the theoretical evaporative power of some hydrocarbon compounds at 22½, we ought not to be surprised that even with rude apparatus, in a merely experimental state, we get an evaporation of 19 or 20 times the weight of the fuel—say 19, at all events. I believe that has been realized in experiments that have been made, and that are now being continued.

There is another phenomenon as to which I may say something—the mode of

operation of steam jets in cases of this kind. There can be no doubt that one use of the steam jet is the mechanical action to which I have frequently referred—the thorough mixing of the gaseous fuel with the oxygen required for the purpose of combustion—the churning of the particles all together, so that they shall be brought thoroughly into contact. There may be another mode of operation of steam—a chemical action whose effect is to prevent the deposition of unconsumed carbon from gaseous fuel. All hydrocarbons have a tendency, when raised to a higher temperature, to deposit the carbon, unless it be instantly burned. We see that in the smoke that a flame tends to give out, if there is anything to prevent immediate and free access of oxygen to the carbon. Now it is possible that besides its mechanical action, the steam jet may also have a chemical action of the following kind:—The oxygen of the steam combines with the carbon of the hydrocarbon fuel, and the hydrogen of both is set free; there is a mixture thus produced of carbonic oxide and of hydrogen, which is sure to be completely burnt as soon as a sufficient quantity of air gets access to it, and thus the deposit of unconsumed carbon is entirely prevented.

I have now gone as far as I think I can venture to occupy the time of this meeting. It would be out of place for me to enter upon the consideration of nautical questions, such as the comparative weight and bulk of different sorts of fuel; therefore I have now only to thank you for the kind attention with which I have been heard.

The Chairman: Does any gentleman wish to make any remarks upon the paper?

Captain Jasper Selwyn, R.N.: This is a subject which has engaged my attention for the past two years. I had the pleasure of bringing it to the notice of this Institution, persuaded as I was of the enormous value of the whole question, more particularly to the Navy of this country. I knew that if the economy which Professor Rankine has put before us, and the use of materials better adapted for such combustion as we require, were once brought into play, that a very great proportion of the unjust fears, which existed two years ago very strongly indeed, as to the consumption of our whole coal supply, would be met by an economy which was the truest method of supplementing any possible failure; though I scarcely believe such to exist. I am sure that had the members of this Institution been more generally aware, particularly my naval brethren, of the very complete way in which the whole question of the economy of fuel would have been brought before them to-night, we should have seen a very much larger attendance than we now see. However, it matters the less, because this is a paper which will be read with the greatest attention in the Journal. It will, I am persuaded, command a very wide class of readers, not alone in the Navy, but among all those who are interested in this great question; among foreigners, as well as our own countrymen. Professor Rankine has followed up, most beautifully, I think, the composition of fuel, the value of each proportionate part of it in accomplishing the effect we desire, the causes of loss, and the possibility of economy. The points to which he has drawn your attention are those which belong to the science which he has cultivated with so much success. The points to which I had the honour of drawing your attention were principally those which affect our own profession, inasmuch as this was a fuel which alone could be burned with greater economy, would require fewer attendants, economizing their wages and victuals, would be attended with more certainty even by inexperienced persons, and would give us the power of stowing and taking it on board conveniently in places where we could not have so stowed it formerly, and with none of those wretched residuary products which we find so much difficulty and so much nuisance in getting rid of. The Professor has adverted to the causes of loss in the deposit of carbon. I think I may ask him whether he is not of opinion that that has another and most important effect, which is that the heating surfaces, becoming covered with such a deposit, lose very materially their efficiency; and that wherever an entire absence of such deposit can be obtained, it not alone indicates economy of the unconsumed carbon which is now burned, but it indicates also the increased efficiency of the heating surfaces, which are left in their integrity, as the maker intended them to exist. The question also of blasts has been brought very strongly before you, showing you the economy of the artificial blast, and where this blast is supplied, at such a point of the furnace as to be itself a contributor to the total heat of combustion, and in this way it becomes clearly very much more valuable. I think I gathered from what Professor Rankine said, that he considered it quite probable that a double decomposition took place, and that the oxygen and the hydrogen of the steam contributed to the total heat of combustion; therefore, although it was necessary for the purpose of the blast to sacrifice a certain portion of the steam generated in the boiler, yet that steam, having done a certain portion of mechanical duty in creating blast, also restored to the boiler a certain proportion of the duty of combustion, and was not therefore so great a loss as some persons would be led to believe. I put this more in the shape of a question, which I hope Professor Rankine will remember in his reply, in order that my naval brethren may be thoroughly aware of what the bearings of the question are upon points which are perhaps a little obscure. The question of burning mineral oils is also very materially a question of price. Now, if we were to bring to this Institution a proposition to burn something which cost £10, £15, £20 a ton, you would probably meet the person who brought forward such a proposition by saying, "We are aware that such great results may be obtained by such expensive fuel, but we think the expense too great to be justified." But we do not do that here. The term "mineral oil" is applied to a wide range of products, many of them refuse products, such products as arise from the distillation of illuminating oils, and from the refuse of gas manufactories, which are known by the name of "dead earth oils," and which are sold entirely as refuse at prices not very materially above that of coke. From a halfpenny to three-halfpence a gallon, I think, is the price at which they are being actually burned at this moment, and doing duty rather in excess, I think, of what Professor Rankine has claimed for them as yet; not in excess of the theoretical evaporative power, but in excess of the power which Professor Rankine claims in his last words—the theoretical evaporative power very largely secured with very little waste; and an economy in all other points, such as he has spoken of being pretty fairly carried out in these early experiments, has resulted in the duty, done by 30 lbs. or three gallons of this dead earth oil, at from one halfpenny to three-halfpence a gallon, being precisely the same as had been previously done in the same boiler, with very little change in it, by 60 lbs. of coal. Now, I hope that this subject will not be allowed to drop; that it will be made the subject of very close study indeed by those who are responsible for the cheap and efficient conduct of our naval affairs. I, for one, have to lament the knowledge which I have recently acquired, viz., that one of our most recently built iron-clads can only carry four days' coal to sea. I say distinctly, and I am sure my naval brethren will say with me, that it is utterly impossible we can go on in that way; that to encounter a great European war with such means of locomotive power, even though we should have carried out the views of seamen, and not of those who advocate fighting machines without masts or sails, although we should have carried into effect good sailing ships as well as good steamships; yet if they can only steam four days, we shall lose the empire of the ocean for want of being able to go to sea under steam, or, I should say, to keep at sea under steam. I hope, then, that some other person will kick the ball again; that this will not be a subject with respect to which it will be said, "There has been a splendid paper read upon it; we will now consider the subject as closed." Let us rather consider it as only now opened—most ably opened by Professor Rankine. I am sure he has given those who are inclined to study the subject at all the materials with which they may do so successfully.

Mr. J. Richardson, C.E.: As regards fuel, I think we may safely say that that fuel is the most valuable which can be burned with the least waste. We all know that the best coal when carefully burned will evaporate 10 lbs. of water to 1 lb. of coal. Laboratory practice is hardly a test of the result in real practice. In this, evaporation is seldom obtained of more than 7 lbs. of water to 1 lb. of coal. There is a cause which considerably accounts for this difference. It is necessary in large furnaces, every seven or eight hours, to remove the clinkers from the fire bars; and in doing so, the stokers seldom stop at two-thirds of the contents of the grate, but they rake out nearly all the contents, clinkers and ashes, and the whole go over the side into the sea. This is not enough: every three or four hours all the ashes are raked out, and they go over the side. Besides the waste of coal in raking out the fires there is also deterioration of coal in hot climates. I have had the opportunity, when at Woolwich, of speaking to engineers there, and they all confess that the amount of evaporation obtained from coke and coal in a long voyage is never more than 6 lbs. of water to a pound of coal. Liquid hydrocarbon can be burned nearly without any waste. A ship starting from Southampton, and going to Calcutta, has only got to get her steam up before she leaves the harbour. She may have her furnace doors locked, and she may keep them locked till she gets to Calcutta; and there may be an evaporation obtained of 16 lbs. to 18 lbs. of water from one pound of fuel, without the slightest change, the whole distance. Evaporation can be obtained without the least trouble to the stokers; they have only to attend to the fire, and see that it does not make too much head, or get on too fast. The fact is that 200 lbs. of this liquid hydrocarbon will produce as much heat as 600 lbs. of coal. I think this is a most important result in favour of these fuels. There is one fuel that has not yet been tried. This is a solid fuel—naphthaline—and I believe is stronger than creosote. I believe it would produce 24 lbs. of evaporation. The Admiralty have given a common service boiler, which is going to be tried, first with coal, and then with the liquid hydrocarbon fuels.

Captain Burgess: What is the price of the naphthaline?

Mr. Richardson: About 18*s.* a ton.

The Chairman: What effect has oxygen when chemically combined with fuel?

Professor Rankine: With respect to the question you have just put, we know from the results of experiment, when oxygen does exist in a state of chemical combination with fuel, that it actually forms water with part of the hydrogen. Its operation is this: it annuls the heating effect of a certain portion of the hydrogen. Suppose in 100 lbs. of a certain sort of fuel there are, we will say, 5 lbs. of hydrogen and 4 lbs. of oxygen, those 4 lbs. of oxygen render $\frac{1}{2}$ lb. of hydrogen inoperative. It does not burn, because it has combined with the oxygen, and it cannot combine with any more. So, while the total hydrogen in the fuel forms 5 per cent. of its weight, the effective hydrogen is only $4\frac{1}{2}$, the remaining portion being rendered inoperative, owing to the presence of the oxygen with which it is able to combine. That seems to be the explanation of the effect of the presence of oxygen in coal. It is well known that it deteriorates the coal. It is further certain that this is one of the causes why coal exposed to the atmosphere becomes deteriorated, and loses heating power. It is equivalent to a partial combustion, leaving so much the less to be burned. Then, with regard to the previous remarks, there is no doubt that all that has been said about the stirring of the fire to remove the clinkers is perfectly sound and perfectly applicable. It is a cause of great waste of heat; and it is important, as regards one objection to the use of coal to which I have already referred, that it leaves so much dependent upon the skill and care of the stoker. There is no doubt that, with very careful firing, the waste from this cause may be reduced perhaps to only about $2\frac{1}{2}$ per cent. of the total evaporative power; but with bad and careless firing, there is no saying how much it may amount to. With mineral oils you are free from dependence upon uncertain matters of that sort. Captain Selwyn put a question regarding the chemical action of a steam jet. There can be no question at all about the advantage of its mechanical action, mixing the air and the fuel together, and bringing the oxygen into thorough contact with the inflammable matter. As to chemical action, as far as chemical action upon steam itself is concerned, it would just amount to this—that the steam is first decomposed into oxygen and hydrogen; and that then the hydrogen is combined with the oxygen again. The result of that, as regards heating power, would be simply nothing. A certain quantity of heat disappears in decomposing water; precisely the same quantity of heat is reproduced by the oxygen combining with the hydrogen again. It is indirectly conducive to a very important saving: all that oxygen which is separated from the hydrogen during the decomposition of the steam serving to hold in solution the carbon of the inflammable gas or oil, and to prevent its being deposited in a solid form. I quite agree with Captain Selwyn. It was an omission on my part not to refer to the prejudicial effect of such a deposit of carbon upon the heating surface, in reducing its conducting power. It is no doubt from a cause like that—from the carbon incrusting the heating surface that cases of this sort have arisen:—a steamer would make her trial trip burning only 4 lbs. of coal, per indicated horse-power per hour. She would start upon her voyage burning the same quantity. The consumption would gradually

rise to 4½ lbs, 5 lbs., and so on, and at the end of the trip she would be burning 6 lbs. of coal per indicated horse-power per hour, without any deterioration in the working or in the management of her engines, but solely from the loss of conducting power, owing to the deposition of the carbon upon the surface of the tubes.

Captain Selwyn: May I say that I particularly wish to have an opinion from you with regard to the difference between the action, chemically and mechanically, of the blast in the chimney and the blast in front of the furnace?

Professor Rankine: I think there is one difference with respect to the mechanical action—that a blast directly into the furnace is much more efficient. It produces a more thorough mixture of the inflammable gases with air than the chimney blast does. A chimney blast in a locomotive is a very convenient thing; but I do believe that you can produce an equally thorough mixture, or a more thorough mixture, by direct blast into the furnace with less expenditure of air. Then, as to the indirect chemical process to which reference has already been made. Of course, if you blow steam into the chimney it does not take place at all. That chemical process that tends in an indirect way to economy of fuel can only take place if you introduce steam in contact with the inflammable gases. I am glad that Captain Selwyn has referred to this matter, because I ought to say something as to the temperature at which steam is introduced. Captain Selwyn has referred to this fact, that it may be said a certain quantity of heat is wasted in generating this steam, but that heat is made available again. Now, that depends, I may say, almost entirely upon the temperature at which the steam is used. You expend a certain quantity of heat in evaporating water, and you send the steam in at a comparatively low temperature. In the ordinary state of saturated steam, the temperature of that, as compared with burning fuel, is cold. It may be very hot as compared with the ordinary temperature of the atmosphere; but as compared with the temperature of fuel in the furnace, it is a very low temperature indeed. A body cannot give out heat to a body that is hotter than itself, so that the heat spent in producing steam at a comparatively low temperature will be wasted; but if you use superheated steam, in the first place a much less quantity of steam will serve the purpose. The mechanical effect depends upon pressure and volume. In order to get a great pressure and a great volume with small weight of material you must employ a high temperature; you must, in short, use superheated steam. As a great part of the expenditure of heat in producing the steam depends on its weight, the use of superheated steam tends to lessen the expenditure of heat for a given mechanical effect. Then, if you raise the steam to a temperature approximating to that of the flame itself, you get back nearly the whole of the heat again; because the superheated steam, being at a higher temperature than the heating surface of the boiler, gives out a great part of its heat to that surface just as the flame does.

The Chairman: I am sure that the meeting will join with me in offering our thanks to Professor Rankine for this lecture—I may say for this lesson. As an old naval officer myself, I feel that during the time when I was captain of a line-of-battle ship I should have been very glad of such a lesson as we have had to-night. I may also add that I hope it will be of great use, not only to us who are going out of the profession, but to those who are rising up in it. I must also make another remark—that the small number who are here present is no measure of the value of a lecture such as this, or of the good that it will effect. There are many others who, thanks to our Journal, will have the opportunity of studying this lesson, naval officers especially. There is a great deal in the professional part of the question which Professor Rankine has thought it right to leave out. But points have been touched upon very ably by Captain Selwyn in almost every one of which I cordially join, because I think those points are of great importance. The efficiency of our Navy will very much depend upon the fuel we shall use in the future, and upon the way in which we shall be able to economize the use of it, or economize the space for it in stowage. Every pound of fuel we shall be able to save hereafter will be so much space gained; not merely space gained for air and so on, but space for efficiency, for the life of the ship, because her efficiency depends upon the quantity of fuel she can stow. She is no man-of-war if she goes to sea devoid of fuel, and is met by an enemy with a good supply. There would be an end of her. We must also remember that all we can gain in the way of space and efficiency will enable us to carry a better armament, and to devote the space saved to other purposes, even if we do not devote it to the life of the ship, viz., the fuel she carries; for fuel to a ship is as the air we breathe. I must again ask you to join with me in thanking the Professor for the very able lecture which he has given us.

THE INSTITUTION OF CIVIL ENGINEERS.

November 12, 1867.—The first meeting of the Session 1867–68 was occupied by the reading of a supplement to and the discussion upon the paper, "Experiments on the Removal of Organic and Inorganic Substances in Water," by Mr. Edward Byrne, M. Inst. C.E., which was read at the close of last session. The author now gave an account of experiments he had since made on the well-known filtering materials, magnetic carbide and silicated carbon; and after recording the results in a tabular form, he proceeded to make a comparison between those substances and animal charcoal

His experiments were to the effect, that the action of the magnetic carbide was exceedingly feeble as regarded the removal of organic and inorganic impurities, and that it did not possess the property of softening the water except to a very small extent; whereas this property was possessed in a high degree by the two other filtering materials. Silicated carbon, however, quickly lost this power, and after a short time it rendered the water positively harder than it was before filtration. Animal charcoal, in its softening property, was not only more powerful than the silicated carbon, but more permanent in its action; and so far as the experiments went, it continued to remove inorganic matter. After a short time, however, it commenced to give back a portion of the organic impurity which it had previously removed. The silicated carbon, too, was found in an equally short time to give back not only the organic, but also the inorganic matter, which it had previously taken up.

To decide whether the organic matter contained in the water, so far as the nitrogen was concerned, had undergone any oxidation by its passage through these substances, the amount of nitrogen in the original water, and in that passed through each filter, was determined by the process which Professor Wanklyn had recently made known. By this extremely delicate test it was found that, for equal quantities of organic impurity, the amount of albuminous matter in the original and in the filtered waters was precisely the same; which fact was considered a sufficiently clear proof, that the organic matter contained in the water had undergone no change by its percolation through these filtering materials.

The author then expressed the opinion, that while filtration must ever be considered most valuable for the removal of matter in mechanical suspension, it was practically useless as a means of removing substances in solution. He argued that the deductions to be drawn from these experiments, though made on a small scale, would, by reason of the systematic manner in which they were conducted, be safely applicable to cases of far greater magnitude. He concluded by expressing a hope, that the result of these investigations would serve the purpose of pointing out the danger of depending too much on the system generally of filtration, as well as of exposing the inconsistency of bringing home foul water to undergo a delusive method of purification; instead of adopting the proper and only satisfactory plan of procuring water which was itself naturally pure.

MONTHLY NOTES.

Education in France.—There does not appear to be so wide a difference in France between artists and artisans, between the man who designs and the man whose duty it is to work out a design, as in this country. As we heard an English workman in another branch of trade observe in Paris, there is much more credit to an English workman if he is clever, for a Frenchman has so many advantages that if he only have moderate talents he can scarcely help but be a good workman. He has excellent schools to give him a primary education, and go where he will there is something to educate his eye and elevate his taste. We have been groping our way in ignorant and bigoted security, and quarrelling in which way education should be given, or denying it altogether, while other nations have been getting before us; and if this Exhibition have no other effect in England than to convince us of our deficiencies, it will have had its mission—so far as we are concerned. The present prosperity of this country is so unmistakably interwoven with its manufactures, and the pre-eminence of these depends so much upon new adaptations, discoveries, and improvements, as to demand for the workers in iron, china, and other departments the readiest and best educational training and enlightenment this nation can give them. It is not only idle but suicidal to dream of remaining where we are. We must strike out in new paths; we must advance with the world or lose caste and trade together. How many men know anything at all of the materials with which they work? Yet such knowledge would sweeten daily toil, would open the treasure-house of thought, and enable a man to convert to new uses elements of force by which he is surrounded, and enrich the nation by adaptations and modes of economizing means now in use. Every man ought to have the means within his reach to enable him to become master of his art. With how many would a knowledge of geology, chemistry, geometry, drawing, and mechanics smooth the path of daily toil, and render labour pleasant! Why should not the miner find compensating pleasure for the darkness and drudgery of the mine in a knowledge of the gases by which he is surrounded, and of the minerals he is extracting from their long resting-place in their subterranean store-house? Let him know something of their history, of the changes and natural processes to which they were subject to bring them to their present state. How cheaply purchased is the pleasure of astonishment with which he might go on reading the hieroglyphics and paintings of nature in the mine, interpreting at each stage the emblems of earlier states and existences. Such an education would tell in many ways. It would tame and civilize the barbarous savages of our mining districts, and enfranchise them as men. While in France we did not see one single case of drunkenness, or one Frenchman quarrelling with another: and we heard the same remark made by a dozen others at least. We were struck, as others were, with the courtesy shown by man to man, and by the affection displayed to children and to old people. We believe that the working men of Paris and their wives dress more plainly, live less expensively, yet enjoy life more than working men in England; and we attribute much of this to the superior education which they receive.—*An English Workman in The Times.*

How the Money Goes.—The great fault in points of design with regard to most of the works on our coasts that have been expressly planned to carry armour-plating, is the overcrowding of each work with embrasures. These works, built of granite, with an iron ribwork of longitudinal and transverse girders, and a sheathing of outer armour, in the disposition of which each embrasure will cost from £1000 to £1500, are supposed to be building to last, not for a few years, but for all time. They can neither, when once planted in the sea—like the Shovel fort in Plymouth Sound, the Spithead forts, or the fort on the Isle of Grain—be reconstructed like a fleet, nor materially enlarged. These forts were all intended to carry the heaviest gun then known, the 23-tonner, or, as it is generally called, the 600-pounder, which has earned such fame at Shoebury; but now that the land batteries at the Gilkicker, at Sandown, at Sheerness, and other points, are nearly ready to receive their iron-plating, it is found that there will not be space for the 23-ton gun, and a lesser weapon will therefore have to be substituted. The same conclusions apply to the marine forts at Spithead and elsewhere. The introduction of submarine mines into the system of defence for roadsteads, harbours, and rivers has, however, rendered the failure of our marine forts to carry their originally intended weight of armament a less serious matter than it would otherwise have been, as it is just possible that all such works may in future be looked upon as grand torpedo stations, with their guns protecting the nests of hidden mines lying in the water channels and on the edges of the shoals, rather than as fighting batteries defending, unaided by any secret bedevilments, the passage from the attack of an enemy's fleet. But there are faults of overcrowding batteries with gunports

in some of the works that are really unpardonable and utterly without remedy unless every alternate embrasure is built up, and half the original number of guns placed in the work. Take the costly Hilsea lines, which were designed to command the entrance to the island of Portsea (on which stands all the naval and ordnance establishments at Portsmouth), as an example. The embrasures have here been placed so closely together that even the earthern covering for the stone-fronted face of the batteries *will not stand*, so acute is the angle given by the short distance between the ports. As the earth is piled up over the top of these batteries the foundations also give way, and huge cracks may be seen opening up through the brickwork in all directions. The want of solidity in the base to support the superstructure is also to be found in almost every piece of new fortification now erecting, or lately erected, around our coasts. In many places this result may have been inevitable from the nature of the ground, but in many cases it has most undoubtedly been assisted by a neglect of precautionary measures, or disregard of any consideration of the condition of the soil, marsh, or shingle on which the fort was to be raised. Forts are now standing, or rather are trying to stand, which are constantly letting slip large slices of their ramparts into the ditch below. These forts carry guns, but not one has yet been fired from their ramparts, nor could it be done with safety, for fear of the whole fort falling prostrate. The Medway forts are, perhaps, the most curious and instructive in their history of all. The so-called foundations of these works only were completed when they split through in the most fantastic forms from their lowest to their highest stones, and had to be braced together with stout iron tie-rods from side to side to keep them from breaking up. The next step was to build up the superstructure. As the stones for this purpose were laid on any one side of a work it sunk in the quaking morass, while the opposite side rose. It was soon evident that no forts could be finished on the Medway's bank; but the difficulty was got rid of by the secretary for War saying in the House of Commons that "it had been determined to abandon the forts on the banks of the Medway, in order that the money with which it had been intended to construct them might be expended upon the Spithead forts."—*The Times.*

The Abutment Engine.—We understand from the manufacturers, Messrs Low and Duff, of Dundee, that they have succeeded in getting several examples of this engine at work for driving various kinds of machinery; amongst others, Messrs. Stewart, of Glasgow, tube manufacturers, have erected one for driving their machinery. Messrs. Low and Duff have replaced the beam engine in their own works by one of the new engines, which they state is doing the same work with a saving of two cwt. of coal per day; whilst the engine at Messrs. Keiller's,* we understand, continues to gives satisfaction. During the meeting of the British Association at Dundee, in September last, the engine was brought under the notice of Professor Rankine, who caused a paper on it by the inventor, Mr. Justice, to be brought before the Institution of Engineers in Scotland at their first meeting in October last. A discussion followed the reading of the paper.

Coinage of 1866.—In the year 1866, 4,047,288 sovereigns were coined at the Mint, and 2,058,776 half-sovereigns, 914,760 florins, 4,989,600 shillings, 5,140,080 sixpences, 4158 fourpences, 1,905,288 threepences, 4752 silver twopences, 7920 silver pence; also 9,999,360 copper pence, 2,508,800 halfpence, and 3,584,000 farthings. Altogether, therefore, money was coined at the Mint in 1866 to the amount of £5,076,676 in gold, £493,416 in silver, and £50,624 in copper, or £5,620,716 in all. Worn silver coin of the nominal value of £115,000 was purchased from the Bank of England, for re-coinage, and a loss of £15,648 was occasioned by its re-coinage.

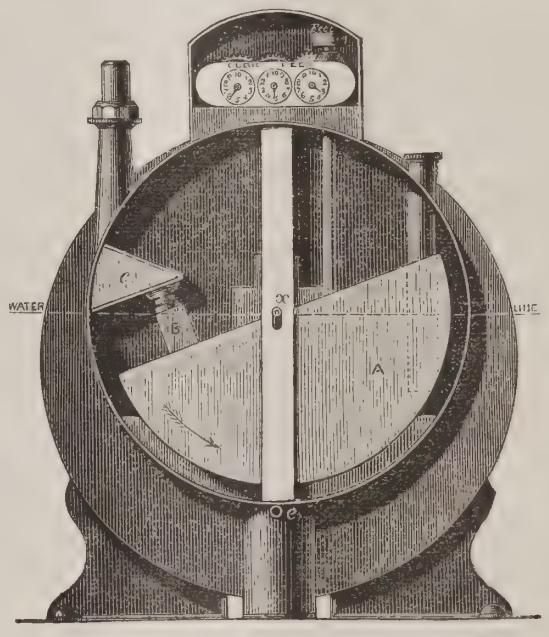
New Docks at Millwall.—The land belonging to the Company amounts to 204 acres, of which 42 acres are covered with water, the remainder being available for wharves and warehouses. The graving dock is 413 feet long, with an entrance 65 feet wide. The lock gates are 43 feet wide by 31 feet high. These docks are to the south of the West India Docks, and their plan has the form of a T.

Italian Railways.—At the beginning of 1864 the length of the railways open in the kingdom of Italy was 3100 kilometres, besides 209 kilometres in the Roman State, and 536 in Venetia, Istria, and the Italian Tyrol. Of the lines conceded there remained to be completed 3870 kilometres, and it is assumed that within ten years from that time the total length of railways throughout the Italian Peninsula will reach 8500 kilometres. Rails are not made in Italy. Attempts were made to supply them at the establishment of Pietrassa, near Naples, in 1856, but it was found that they could not be delivered at less than double the price of those imported from England or Belgium. Neither can chairs, turntables, &c., be manufactured cheaply enough to compete with similar articles of foreign production. There are several establishments for the construction and repairing of rolling stock in Italy. At those of Sampierdarena at Genoa and Pietrassa at Naples, locomotives and tenders are turned out which cost little more than those coming from abroad. Large workshops for repairs of locomotives, &c., exist also at Turin, Milan, Verona, Savigliano, Florence, Lucca (where tubular beams for bridges are also made), Siena, and Civita Vecchia.

Peat in Holland.—From its properties of giving out heat and light, its ashes affording rich manure, its soot being valuable for cleaning pots and pans, and its smoke for preserving fish and meat, turf is endeared to every peasant as an article of primary importance to his domestic comfort. The three northern provinces of Friesland, Drenthe, and Groningen, owe most of their well-being to their peat. There the proprietor of the soil, after exhausting one layer of turf, and reaping splendid crops without manure from the alluvial soil laid bare, often after a while removes the alluvial soil to some neighbouring sandy waste, discovering under it fresh layers of peat, and still more alluvial soil. The depth to which cultivation is thus carried by successive removals of peat and soil often exceeds twenty feet. In the three provinces above named, but especially in Overyssel, there exist, on the borders of large lakes, floating turbaries, bits of which may be cut off in strips, according to the width of the canals they have to traverse, and floated down to market. Many legends are told of the embarrassments these floating turbaries have caused. Many a farmer has been compelled to tether his fields to prevent their floating away: and when desirable to keep flocks and herds separate, these fields have been pushed off from the shore, and anchored at a distance. Then perhaps a storm has suddenly arisen, the fields have dragged their anchors, and floated out to sea.

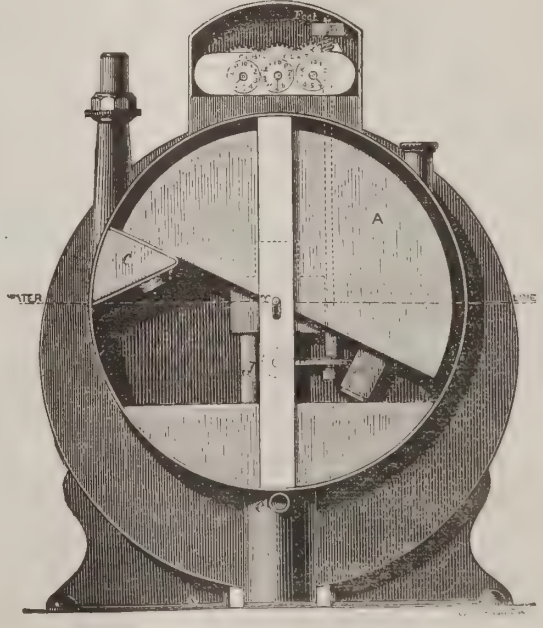
Gas Meter.—The annexed figures are side views of the gas meter manufactured by the Gas Meter Company of London, Oldham, and Dublin, in which the water is maintained at a constant level. In fig. 1 the compensator, A, is in the position to

Fig. 1.



shut off the entrance of gas into the interior of the meter, the measurement of course being no longer correct if the least extraction or evaporation of water takes place. A is the float provided with a spindle, which works freely in suitable bearings; a plug, B, fitted to the valve which is attached to the box, C, closes the passage of the gas when there is a deficiency of water. Fig. 2 shows the position of the

Fig. 2.



compensator when the meter is filled with water; the surplus water escapes through the pipe, *d*, and is drawn off by the pipe, *e*. In the case of evaporation, or loss of water from other causes, the deficiency is supplied by the descent of the float, and thus the level of the water is constantly maintained at the same height.

* In a notice of the engine in the pages of this Journal in March last, the following sentence occurs, viz.:—"One of them being used for driving the machinery employed for reducing the oranges, and possibly turnips, carrots, &c., at the extensive marmalade manufactory of Messrs. Keiller, Dundee." We regret that the allusion in the sentence above quoted respecting Messrs. Keiller's manufactory was inserted in our Journal, and we now gladly retract it, as we are well assured that no adulteration is permitted in Messrs. Keiller's works, and we had no other grounds for believing that such was ever practised or allowed, except that some years since analyses were published of some of the material reported to have been prepared in England in which impurities of the kind we have mentioned were then said to have been detected.

LATHE APPLIANCES.—A few years ago lathe appliances as now manufactured were almost unknown, but now no lathe is considered complete for working unless it has, besides its complement of drivers, several chucks and other fixtures fitted to it. Even at this day we occasionally see some of the older mechanics disdain to use the modern apparatus. For instance, instead of using the concentric chuck, we see them fit a wooden block to the face-plate of the lathe, and as it revolves with this plate they turn its face true, often using an old file for a turning tool, after having carefully ground it to a cutting edge, and sinking a recess in this block to hold the work, they carefully fit it to its intended receptacle. The chuck formerly in use consisted of an iron disc fitted to revolve upon the lathe spindle. At four different points, equidistant from each other, upon the face of this plate were four projections, one at each point, and placed so that their outer diameter was even with the diameter of the plate, of which they were a solid portion. The thickness of these projections was sufficient to withstand a heavy strain without breaking, as they were drilled and tapped to receive each a steel set screw which passed through it, pointing to the centre of the plate, and confining the work placed between these screws at their several inner ends. An improvement followed upon this chuck, and, instead of the four projections, four grooves were cut transversely in the disc and a jaw fitted to each groove and made to traverse the groove by means of a screw passing through it, but placed sufficiently in the rear of the face of the appliance so as not to interfere with the work to be inserted and held by the jaws. This form of chuck is in use at the present time, and is a valuable tool to the mechanic who wishes for an appliance which will operate eccentric or with independent jaws, and designed to hold work of irregular forms. This chuck can be made quite strong, and at the same time be made light, and is consequently easily handled. As mechanical skill progressed, an appliance was required that would operate concentrically or with jaws which should approach or recede from the centre simultaneously, and as a result we see the scroll or concentric brought into use. With this appliance the workman can insert and execute a piece of work with no loss of time, as would be the case were the wooden block to be fitted and used, or even where the independent jawed chuck is employed. As we often see the mechanic obliged to take his chuck in pieces to remove dirt and accumulations of oil which will collect upon its interior, we may argue that the chuck is not yet perfect. The result will be the production of a chuck that will be impervious alike to both dust and oil. It is but a few years since that we were accustomed to see drill-shanks made square and fitted to be revolved in a corresponding recess made in the end of the lathe spindle, and it would have been thought an almost impossibility to rotate them if made of any other form. But now nothing is more antiquated than a drill-shank of this character, and we now see drill-shanks made round, and can readily purchase chucks which will centrally clasp and securely hold them, no matter what the size of shank may be. For this little invention we are indebted to the twist-drill, a tool which is also a specialty of manufacture in several places. Nor are chucks a tithe of the appliances which might be mentioned as being fitted to lathes, and which are made a specialty by many manufacturers. The field for inventions of this character is large, and but little has as yet been done in it; and it will be observed that where these appliances have been offered they have found ready sale, and in many instances their use has become general. —*American Artisan.*

NEW DOCKS AT BARROW-IN-FURNESS.—The district of Furness is a detached portion of the county of Lancaster, jutting out into the sea on the northern side of Morecambe Bay, and Barrow forms almost the extreme point of the promontory. At the time the Furness Railway Company commenced operations in the district, Barrow was but a small village, consisting of three or four old farm houses and farm buildings, eight or ten low-roofed cottages of corresponding date, and a couple of public houses. In 1847 the population was 325; at the present moment it exceeds 17,000. The iron ore annually shipped from Barrow amounts to upwards of 600,000 tons. At Hindpool, a short distance from the new docks, eleven blast furnaces are in full work, and something like 5000 tons of pig iron are manufactured weekly. Although it is estimated that the total cost of the docks and works attached to them will be about £300,000, it is alleged that no docks in the kingdom enjoying similar accommodation were ever made for so small a sum. The mode in which the site was turned to account by the contractors, Messrs. Brassey and Field, acting under the direction of the engineers to the railway company, Messrs. M'Clean and Stileman, will be understood from these details. Of the numerous islands on the south side of the peninsula, the nearest, Barrow Island, was separated from the town by a narrow channel. The railway company, however, reclaiming and encroaching more and more upon the sea, reduced the distance between the island and the mainland till there was only a tide-way left of some few hundred yards in width. This tideway the engineers already named determined by inclosure to convert into floating docks, so that the island and the mainland should in future be one, with the water space between no longer a free channel for the sea, but a basin or basins in which vessels might float securely at all states of the tide. An outer island, Walney, ten miles in length, acts as a natural breakwater to Barrow; and it is estimated that around and in different parts of another island called Barrow Island, which the railway company has purchased, there will be something like 10 miles of railway s dings. The docks will be adapted for the accommodation of vessels of all sizes. In dealing with a tideway, sometimes very rapid, it was of course necessary to commence the operations for inclosure at one extremity, and by the construction of a central pier to complete one dock before the corresponding wall at the other end of the channel could be erected. The first, or Devonshire Dock, has thus been constructed, and is now actually occupied by vessels. The second, or Buccleuch Dock, wants only the second wall to be built, to be ready likewise for the accommodation of shipping. The plan adopted has been to construct the docks with one deep or walled-in side, that nearest to the mainland, leaving the other shelving, so as to be turned to account in whatever manner may hereafter be found most advantageous for the manufactures carried on upon Barrow Island. By means of a floating caisson the expense of constructing two pair of dock gates and the heavy masonry necessary for them has been avoided. As showing the capacity of the docks, the following details may be of interest. The entrance is 60 feet wide, and the depth of water maintained 22 feet. The stone quays are a mile and a half in length. The water-area of the Devonshire Dock is 30 acres; that of the Buccleuch Dock will be 33 acres; and of the timber-pond immediately adjacent 35½ acres. The wharves adjoining the docks are 100 acres in extent; and warehouses, four stories in height, with a floor area of 17,000 square yards, have been erected, abutting upon the Devonshire Dock. Hydraulic capstans are provided at the entrances, and hydraulic cranes on the quays and in the warehouses. Independently of the land which the company may require for themselves, there are no less than 230 acres in their possession, available for private shipbuilding yards, timber yards, and works. The following summary of distances shows the situation of these docks as regards the timber and other shipping trades for North Lancashire and the Cumberland district:—From Leeds, 93 miles; from Hull, 147 miles; from Middlesborough, 121 miles; and from Durham, 123 miles.—*The Times.*

PARIS EXHIBITION.—DE LA COUX'S LUBRICATOR.—This apparatus is composed of a glass reservoir, A, into which is screwed a copper ring, *c*, attached to a tube of the same metal closed at its lower end and perforated with two small holes, *d* and *e*, the former of which is for the supply of oil to the shaft requiring to be lubricated, and the latter allows a free passage to the air which when the shaft turns is introduced into the apparatus. The latter hole is made in a small movable cap, *m*, which fits the tube, and can be removed when it is desired to clean out the same. In order to introduce the oil it is only necessary to unscrew the ring, *c*, and pour in a sufficient quantity of oil into the reservoir, A. The apparatus being fitted to the bearing to be lubricated, when the shaft is put in motion the oil is drawn drop by drop from the reservoir and is replaced by an air-bubble, and the oil ceases to flow with the cessation of the motion of the shaft. The efflux of the oil recommences as soon as the shaft is set to work again, the quantity of oil supplied being always in proportion to the velocity of rotation of the shaft. This arrangement is susceptible of various modifications to suit the form and position of the different apparatus requiring to be lubricated.

PARIS EXHIBITION.—COIGNARD'S SEWING MACHINES.—M. Coignard, of Nantes, exhibits specimens of his improved sewing machines, which are of that description in which a shuttle is used. The chief peculiarities of his machines consist in the substitution for the holes and springs employed for the tension of the threads in the ordinary shuttle, of a rod or roller of polished steel forming a lever on which the thread is rolled as it proceeds from the bobbin. This roller, which is adjusted in the shuttle, acts with a spring, and is maintained by a screw; its size is determined mathematically, so that three turns on the roller give the exact tension, from the commencement to the end of the bobbin, without shocks or strains, or deteriorating either the thread or the shuttle. As it leaves the roller the thread passes through a guide-ring and a large steel eyelet, which latter is placed at the top part of the shuttle, and at such a distance as to prevent any oscillating motion of the shuttle or shifting from the point, to which defects the ordinary shuttle with its central holes is especially liable. In addition to the above arrangement of the shuttle, M. Coignard's improvements embrace some modifications in the bobbin. The piston, instead of being welded to the arm, as is usually the case, is attached by a screw, so that when broken it may be replaced by a new one with the greatest facility. He also substitutes for the ordinary bobbin a spindle, on which a loose bobbin is placed. These bobbins are sold with the thread at a certain price per dozen, and when one supply of thread on the bobbin is exhausted, the bobbin has merely to be replaced by a fresh one upon the fixed spindle. We have only to add that M. Coignard's shuttles may be applied to sewing machines on other systems, and that they cost no more than shuttles of the ordinary kind.

AUSTRALIAN STATISTICS.—The total area of Australia is 2,582,070 square miles, and its population in 1861 was 1,266,432. In the year 1865 the gross amount of public revenue was £8,958,092, and the gross amount of expenditure £9,147,499. The total tonnage of vessels entered and cleared (exclusive of the coasting trade), during the same year, was 4,091,467, as compared with 1,767,305 in 1852. The total value of imports has, with a single exception, been regularly and largely progressive during the past fifteen years, for it reached £8,086,225 in 1852, and in 1865 had risen to no less than £35,145,053 sterling. The exports have in the same interval increased from 15½ to more than 30 millions sterling, and the value of exports to the United Kingdom alone have risen by about £2,000,000 sterling. In most respects our Australian colonies exhibit their highest returns in 1865, except Tasmania, which country reached its *maximum* of revenue in 1858, its *maximum* of imports in 1854, and of exports in 1853, and its *maximum* of exports to the United Kingdom alone in 1852. The public revenue of New South Wales has during the past fifteen years increased from £682,000 to more than £2,000,000; of Victoria from £1,500,000 to more than £3,000,000; of South Australia from £243,000 to more than a million; and of New Zealand from £161,000 to £1,500,000 sterling. The exports of gold from Victoria during 1865 were valued at £6,190,317, and from New Zealand at £2,252,689 sterling. The wool exported from New South Wales in the same year was valued at £2,253,149, and that from South Australia at £974,397, the last sum being nine times greater than that recorded under the same heading for the year 1852.

INDIAN RAILWAYS.—At the beginning of 1866 there were 3331 miles open, 205 were finished during the twelve months, and 101 miles since, thus raising the total to 3637. The completion of the Great Indian Peninsular to Nagpore places India in a greatly improved position for providing this country with cotton. The East Indian line to Jubbulpore has just been opened to the public, and it is expected that the Great Indian Peninsular will, by October or November, 1868, effect a junction at that place, which will establish a through communication between Bombay and Calcutta. The total length of railways remaining to be constructed, and for which a government guarantee has been granted, is 2005½ miles. In addition, proposals have been considered for three lines—namely, one of 570 miles from Baroda to Delhi, one of 500 miles to unite the Scinde and Punjaub, and one of 250 miles from Lahore to Peshawur. The first would cost £6,840,000, the second £6,000,000, and the third £5,000,000, making a total of nearly £18,000,000. It has been determined not to authorize the Lahore and Peshawur, and no decisior

has yet been come to with respect to the others, but surveys are being carried on. There are also projects for a chord line for the Great Indian Peninsular Railway, an extension of the Madras Railway to the sea-coast, and an extension of the East Indian across the Hooghly into Calcutta. The total capital thus far raised for Indian lines is £67,254,802, and the further lines already authorized will raise this to £88,000,000. The receipts of the year ended the 30th of June, 1866, were £4,537,235, while the expenses for working and maintenance were £2,225,495, showing a net profit of £2,304,534—a result which contrasts favourably with the working expenditure of our largest English companies, notwithstanding the adverse influence of dear fuel. At the existing rate of freights, coal and coke, before they are landed in India, cost 50*s.* per ton, and the extra charges, so far as the Western and Southern districts are concerned, raise the cost to about 60*s.* The East Indian Company have exceptional advantages from the coalfields near Calcutta, and the cost to them of coal per train mile is $3\frac{1}{4}d.$, while on the Great Indian Peninsular it is 1*s.* $6\frac{1}{4}d.$

THE CENTRAL PACIFIC RAILWAY.—This line was begun in 1863 at Sacramento, and was planned to cross the sierras at an elevation of 7042 feet. Ninety-four miles, the distance between Sacramento and Cisco station, have been completed, and 5911 feet of the ascent have been made. This portion of the work has cost about 100,000 dollars per mile. The ascent is continuous; the average rate being 75 feet to the mile; the maximum, 116 feet to the mile, of which there are but $3\frac{1}{2}$ miles. The greatest part of the heavy gradient is at 105 feet to the mile. None of the curves have a radius of less than 573 feet. By crossing from one spur and ridge to another, and passing through short tunnels and deep cuts, the line has been made available for passenger trains to run at 25 miles an hour, and goods trains at half that speed. The time consumed in travelling the 94 miles, including stoppages, is six hours, with ordinary engines and trains. The crest of the ridge is pierced by a tunnel of 1658 feet, the longest on the road. This tunnel occupied about a year in construction. A shaft, 159 feet deep, was made at the centre, where there is a depression in the crest, so that the men were working at four faces at the same time. The progress of excavation through the granite was very much increased by the employment of nitro-glycerine, manufactured on the spot. The majority of the workmen were Chinese. East of the summit the descent is much easier, the great interior basin being elevated 4000 feet above the sea level. In 14 miles there is a fall of 1100 feet, after which there is a gentle slope, nowhere exceeding 45 feet to the mile, eastward toward Salt Lake City, which is distant 575 miles from Cisco. It will be necessary to erect sheds over two miles of the road, in order to shoot the snow-slides clear of the track. Provision is made throughout for a double line.

APPLICATIONS FOR
PROVISIONAL PROTECTION FOR INVENTIONS
UNDER THE PATENT LAW AMENDMENT ACT.

☞ When the city or town is not mentioned, London is to be understood.

18th October, 1867.

2921 J. Hale, Stamford Street—An entwining pocket garter
2922 F. Prudencio, F. Cooper, and J. F. Coterell, Manchester—Stoppers for bottles
2923 H. W. Garrett and G. Holcroft, Manchester—Fire-arms
2924 H. Sharp and F. W. Webb, Bolton—Smiths' anvils
2925 E. Casper, Cannon Street—Preventing the bursting of tubes.—A com.
2926 J. Hill and S. Shelley, Manchester—Preparing weft
2927 E. T. Hughes, Chancery Lane—Hats and bonnets
2928 W. H. Tasker, Bradford—Shuttle eyes
2929 J. Seward and H. Smith, Clayton-le-Moors—Steam boilers
2930 T. Kitchen, Accrington—Grinding wheat
2931 H. J. Bale, Oakley Square—Cooking with gas
2932 T. Whitehead, Holbech—Spinning fibrous substances
2933 S. S. Maurice, Monkwell Street—Improved fastenings.– A com.
2934 J. King, Pinaton—Lifting machines
2935 J. J. Holden, Bermondsey—Cleaning and polishing boots
2936 C. Montagu, Cannon Street—Manufacture of articles of apparel
2937 M. Alea, Cheltenham—Davits for ships

19th October, 1867.

2938 F. W. Waide, Rotherham—Decorating dwelling houses
2939 M. J. Matthews, Glasgow—Pianofortes
2940 W. Liebermann, Christian Street—Churns
2941 W. R. Lake, Chancery Lane—Fire-arms.—A com.
2942 A. F. Jalourean, Paris, and C. L. Lardy, Switzerland—Telegraphic cables
2943 L. Newton, Oxton, and J. Swailes, Oldham—Stoppers for bottles
2944 J. Schwartz, Pelham Street—Cooling or refrigerating water
2945 F. Adkins, Rowley Regis—Hoes
2946 J. Anderson, Ballymacarrett—Felts
2947 E. Butterworth, Calder Cottage—Preparing and spinning cotton
2948 M. W. Shove, George Street—Letter-boxes
2949 R. Watkins, Millwall—Discharging projectiles.—A com.
2950 H. Hughes, Homerton—Ornaments for dresses

21st October, 1867.

2951 M. B. Nairn, Kirkaldy—Power-looms
2952 W. Crossley and T. C. Hutchinson, Middlesborough-on-Tees—Alumina
2953 W Barrett, Norton, and C. Martin, Chancery Lane—Tuyeres for blast furnaces
2954 C. D. Abel, Chancery Lane—Screw bolts and nuts.—A com.
2955 J. Hunter, Greenwich—Signalling on railways
2956 J. Clapier, Paris—Hygienic pillows
2957 A. H. Brandon, Paris—Artificial legs.—A com.
2958 C. Duncombe, Newton Grange—Charging and closing cartridge cases
2959 H. Hughes, Homerton—Bottles
2960 W. R. Lake, Chancery Lane—Electric telegraph apparatus.—A com.

22nd October, 1867.

2961 J. Adams, Strand—Breech-loading revolver fire-arms
2962 T. Webb, Cross Street—Sewing machines
2963 C. Ritchie, Pimlico—Tobacco pipes
2964 T. Lemielle, Valenciennes—Fans for ventilating mines
2965 P. and A. Walker, Dalston—Shoes for horses
2966 N. A. Thoumelet, Peckham Rye—Cutting paper
2967 G. Jones, Ynysgoed—Mounting wheels on road carriages
2968 J. White, Great Portland Street—Ventilating buildings
2969 W. Beale, Taunton—Telescopic apparatus
2970 H. W. Sambridge, Birmingham—Gasaliers
2971 A. V. Newton, Chancery Lane—Dredging.—A com.
2972 W. Gray, Sheffield—File blanks
2973 W. Brookes, Chancery Lane—Treating hides.—A com.

23rd October, 1867.

2974 J. Haddock, Ratcliffe—Shuttle tongues
2975 C. D. Abel, Chancery Lane—Pulverizing material for porcelain paste.—A com.
2976 T. Welton, Fitzroy Square—Oxygenated bread
2977 F. J. Bugg, Ipswich—Pressed leather
2978 F. Seiler, Berne—Compressing air
2979 C. S. Jeaffreson, Royal Free Hospital—Treating fractures of the limbs
2980 A. M. Clark, Chancery Lane—Steam governors.—A com.
2981 J. L. Norton, Ludgate Hill—Sinking wells.—A com.

24th October, 1867.

2982 A. Chambers, North Providence—Files
2983 H. R. St. Martin, Marylebone—Ornamenting glass
2984 F. Gerhartz, Cologne—Manures and disinfectants
2985 J. Thom and A. Maclure, Glasgow—Ornamental fabrics
2986 R. W. Thomson, Edinburgh—Wheel for steam carriages
2987 J. Ellison and J. Stirk, Leeds—Economizing fuel
2988 W. E. Gedge, Strand—Nails.—A com.
2989 G. Olney, Brooklyn—Illuminating gas
2990 J. Dodge, Manchester—Cutting files
2991 H. Adcock, Woodville—Kilns for burning pipes
2992 J. Mitchell, Sheffield—Buffers for railway carriages
2993 H. Ritchie, Billiter Street—Carriages
2994 S. Stackard, Great Tower Street—Bottling apparatus
2995 A. M. Clark, Chancery Lane—Motive power.—A com.
2996 J. H. Johnson, Lincoln's Inn Fields—Spinning machinery.—A com.
2997 C. W. Harrison, Clapham Junction—Preventing incrustation in boilers
2998 R. Weare, Compton—Receptacles for urine
2999 E. M. Palliser, Newcastle-upon-Tyne—Reservoirs for explosive compounds

25th October, 1867.

3000 W. and D. Fisken, Stamfordham—Boilers
3001 G. Russo and C. A. Maccaroni, Florence—Saving lives
3002 L. Stockman, Eton—Rollers for window blinds
3003 G. J. Gunther, Stamford Hill—Plating ships of war
3004 H. Wilson, Stockton-on-Tees—Valves
3005 W. R. Lake, Chancery Lane—Carpet linings.—A com.
3006 W. R. Lake, Chancery Lane—Preserving meat.—A com.
3007 T. Stennett, Strand—Dressing bags
3008 A. M. Clark, Chancery Lane—New mode of obtaining information.—A com.
3009 A. M. Clark, Chancery Lane—Postage stamps.—A com.
3010 P. Love, Northampton—Supplying food to cattle
3011 B. Cooper, Frome—Removing knots

26th October, 1867.

3012 J. A. Hopkinson and J. Hopkinson, jun., Huddersfield—Steam-engine indicators
3013 R. Carter, Leyland—Looms for weaving
3014 G. and E. Dorsett, and J. R. Blyth, London Street—Economizing fuel
3015 W. E. Wiley, Birmingham—Holders for lead
3016 R. M. Letchford, Bethnal Green—Matches
3017 W. R. Lake, Chancery Lane—Levels.—A com.
3018 L. Newton, Oxton, and T. Kershaw, Oldham—Bottles
3019 F. M. Smith, Waltham Abbey—Armour plates
3020 J. J. Perry, Red Lion Square—Binding books.—A com.
3021 J. Brooks, Bristol—Obtaining motive power
3022 C. E. Hall, Leeds—Reaping and mowing machinery
3023 W. Kendall, Percy Main—Locomotive engines
3024 J. Asser, Strand—Croquet mallets
3025 A. M. Clark, Chancery Lane—Steam generators.—A com.
3026 A. M. Clark, Chancery Lane—Railway and other breaks.—A com.

28th October, 1867.

3027 W. Payne and A. B. Fraser, Liverpool—Ships' pumps
3028 J. de Silva, Liverpool—Coating the bottoms of ships
3029 G. Smith, Liverpool—Marking boards
3030 H. A. Bonneville, Paris—Paper bags.—A com.
3031 W. E. de Bourrau, Bordeaux—Evaporators
3032 J. Young, Aspull—Gas and coke
3033 C. E. Brooman, Fleet Street—Lace.—A com.
3034 A., J., W., B., and S. H. Waterlow, London Wall—Printing from copper
3035 J. Glover, Clerkenwell—Furnaces for steam boilers
3036 M. Henry, Fleet Street—Balloons.—A com.
3037 T. Bennett, Birmingham—Spoons
3038 W. Potts, Handsworth—Metallic screws
3039 H. G. P. Meade, Belgrave Square—Fire-arms
3040 V. V. de Cresalles, Strand—Obtaining power from rivers or streams of water
3041 W. R. Lake, Chancery Lane—Centrifugal machines

29th October, 1867.

3042 E. R. Wilson, Bolton—Furnaces
3043 G. W. B. Edwards, Bredfield—Dibbling and dropping seed
3044 J. Smyth, Woolwich, and S. Kirby, Bedford—Musical instruments
3045 E. T. Hughes, Chancery Lane—Twisting lines.—A com.
3046 J. T. Carter, Sydenham—Circular webbing
3047 W. Bishop and B. Burningham, Camden Town—Preventing effluvia
3048 J. H. Johnson, Lincoln's Inn Fields—Cleaning cotton.—A com.
3049 W. P. Savage, Hilgay—Excavating soil
3050 L. Parkins, Seaford Street—Water meters

30th October, 1867.

3051 G. Davies, Lincoln's Inn—Preventing incrustation.—A com.
3052 W. H. A. Bowhay, Modbury—Horse ploughs
3053 J. Feather, Howarth—Cap frames
3054 J. Maddocks, Manchester—Securing nuts and bolts
3055 J. B. Fenby, Birmingham—Valves for hydraulic presses
3056 T. E. Symonds, Adelphi—Ships and other vessels
3057 F. Piercy, Strand—Colouring photographs
3058 J. H. Johnson, Lincoln's Inn Fields—Holders for whips.—A com.
3059 Earl of Caithness, Hill Street—Cleaning boiler tubes
3060 A. V. Newton, Chancery Lane—Ventilation of buildings

31st October, 1867.

3061 C. Jobson, Newcastle-on-Tyne, and J. Jobson, Poplar—Screw propellers
3062 R. Clegg, Islington—Pumps
3063 W. Hall, Ashton-under-Lyne, and J. Wren and J. Brandwood, Manchester—Toothed wheels
3064 W. S. Dixon, Bellisle—Blue dye
3065 E. Donner, Brussels—Clearing skins destined for hatters
3066 J. T. Caird and S. Robertson, Greenock—Transmitting motive power
3067 O. C. Evans, West Dulwich—Digging machinery
3068 W. R. Lake, Chancery Lane—Cap for furniture springs.—A com.
3069 W. R. Lake, Chancery Lane—Preserving food.—A com.
3070 J. Kendricke, Walworth—Steam boilers

3071 J. Watkins, Balsall Heath—Axles for carriages
3072 A. Chaplin, Chelsea—Distilling apparatus
3073 D. Sykes, Ashton-under-Lyne—Decorticating grain
3074 F. Tew, Falcon Square—Drawer suspenders

1st November, 1867.

3075 R. B. Roden, Usk—Breech-loading fire-arms
3076 J. Sturgeon, Bolton-le-Moors—Getting coal
3077 H. and G. S. Hunter, Liverpool—Hats and caps
3078 G. Haycraft, Lombard Street—Filling flasks
3079 J. Gilmour, Glasgow—Pianofortes

2nd November, 1867.

3080 S. Parr and A. Strong, Cannon Street—Building bridges
3081 J. Wright and M. B. Nairn, Kircaldy—Power looms
3082 M. A. Soul, Leadenhall Street—Securing metal bolts
3083 W. Darcey, Aberclyn—Fastening and strengthening gates
3084 J. Scott, City Road—Shades for lamps
3085 A. G. Avenell, Bethnal Green—Frame for carrying bottles
3086 W. E. Gedge, Strand—Hat cover.—A com.
3087 H. W. Grylls, Dalston, H. Neville, Mile End, and J. Holt, Hackney Road—Motive power
3088 R. Parry, Newton—Corsets
3089 J. J. Hicks, Hatton Gardens—Brushes
3090 A. M. Clark, Chancery Lane—Motive power.—A com.
3091 T. B. Cutts, Wilford, and F. W. Brooksbank, Nottingham—Lace
3092 W. Cook, Jermyn Street, and W. Francis, Clapham—Mats and matting
3093 J. Orr, Glasgow—Plaiting woven fabrics

4th November, 1867.

3094 C. Riley, Whetstone—Tubular boilers
3095 W. Day, Forest Hill—Sheathing composite ships
3096 J. Fraser and G. Duncan—Counter check books
3097 W. Dickinson, Leeds—Joining leather
3098 R. Ackroyd, Halifax, and G. Podgson, Bradford—Looms for weaving
3099 J. Clarke, jun., and T. Holt—Warping
3100 R. Baguley, Blackburn—Shuttles
3101 H. Hebden, Bolton—Mules for spinning
3102 A. A. L. Harrison, Brompton—Label bands
3103 T. Wright and J. Fox—Plain and fancy weavings
3104 N. Birkenruth, Hatton Garden—Mattresses.—A com
3105 J. Kidd, Paul's Wharf—Artificial light
3106 A. V. Newton, Chancery Lane—Sewing machines.—A com.
3107 W. E. Newton, Chancery Lane—Covering steel or iron plates with copper
3108 W. R. Lake, Chancery Lane—Substitute for india-rubber.—A com.

5th November, 1867.

3109 W. Marshall, Old Basford—Clipping lace
3110 H. Allman, Ampthill Square, and F. N. Gisborne, West Strand—Carburetted gases
3111 A. Verdalle, Paris—Closing doors or windows
3112 T. Wingate, jun., Whiteinch—Anchors
3113 T. Briggs, jun., Manchester, and W. E. Yates, Strangeways—Looms
3114 S. H. Foster and T. Bunney, Leicester—Looped fabric
3115 H. Smyth, Little Trinity Lane—Umbrellas
3116 H. Adeane, Hampstead Road—Protecting the eyes
3117 C. E. Brooman, Fleet Street—Reckoning apparatus.—A com.
3118 E. C. Vine, Little Britain—Stays
3119 A. M. Clark, Chancery Lane—Railway brakes.—A com.
3120 R. Palmer, Ovington Square, and H. S. Hird, South Croydon—Wheaten flour
3121 W. Geeves, Barnsbury—Panel doors and frames
3122 W. E. Newton, Chancery Lane—Steam boilers.—A com.
3123 A. V. Newton, Chancery Lane—Antifriction journal boxes.—A com.
3124 A. M'Dougall, Manchester—Stirring solid substances and exposing them to the action of air
3125 J. W. R. Hill, Chancery Lane—Propelling rocking horses

6th November, 1867.

3126 R. Leake and J. Beckitt—Polishing cylinders
3127 E. C. Prentice, Stowmarket—Treatment of gun cotton
3128 T. F. Cashin, Sheffield—Railway signals
3129 H. A. Bonneville, Paris—Preserving pasty matters.—A com.
3130 W. E. Gedge, Strand—Venetian blinds.—A com.
3131 R. Newton, Keighley—Fuel feeding apparatus
3132 J. Baggs, High Holborn—Producing chlorine
3133 E. and R. Thornton, Elland—Steam boilers
3134 W. Pearson and W. Spurr, Birstal—Looms for weaving
3135 J. Botterhill, Leeds—Dyeing fabrics
3136 W. R. Lake, Chancery Lane—Waterproof fabrics.—A com.
3137 A. M. Clark, Chancery Lane—Pianofortes.—A com.

7th November, 1867.

3138 C. L. Hett, Bolton—Steam governors
3139 T. R. Bardsley and W. Blackshaw Manchester—Smoke consuming
3140 T. J. Baker, Farndon—Grinding wheat
3141 E. Sephton, Liverpool—Arrangement of blocks
3142 W. J. M. Rankine, Glasgow—Uniform rotation
3143 C. H. Bright, Westminster—Street tramways
3144 C. H. Bright, Westminster—Carriages
3145 E. Sacre, Westminster—Armour for defence of ships
3146 R. T. Newnham, Bath—Playing games
3147 J. Hewitt, Hoxton—Forming labels
3148 J. F. Brinjes, Whitechapel—Distilling liquids
3149 J. Wheeler, Regent's Street—Gloves
3150 R. Robinson, Rochdale—Filtering paper
3151 T. Clark, Gray's Inn Square—Permanent way of railways

8th November, 1867.

3152 T. Blackburn, Blackburn—Looms for weaving
3153 C. Anderson, Fettykil—Adjusting endless-travelling webs
3154 J. M'Kimm, Glasgow—Indicating horizontal or vertical lines
3155 J. W. Smith, Tenter St., and T. Petitjean, John St., West—Warming apparatus
3156 H. Jewitt, Kentish Town—Exhibiting figures.—A com.
3157 G. W. R. Pigott, Covering wire
3158 S. Landells, Gateshead—Glass globes
3159 W. Inglis, Manchester—Shaft couplings.—A com.
3160 P. H. Nathan, Manchester—Producing patterns.—A com.
3161 T. Wrigley, Manchester—Permanent way of railways
3162 S. A. Kirby, Bedford—Paraffin and other lamps
3163 W. Chippindale, Harrogate—Coupling railway carriages
3164 G. T. Bousfield, Brixton—Setting types.—A com.

9th November, 1867.

3165 J. E. Castex, Camden Town—Harmonium piano.—A com.
3166 S. Hall, Birmingham, and M. Whittingham, Wolverhampton—Locks
3167 H. Ellis, Ludgate Hill—Parasols
3168 E. B. Wilson, Bolton—Furnaces
3169 J. Gresham, Manchester—Giffard's injector
3170 S. Simon, Falcon Square—Aprons.—A com.
3171 M. Rollason, Birmingham—Gas lamps
3172 T. W. Ingram, and E. C. Kemp, Birmingham—Gas lamps
3173 C. Bedells, Leicester—Slipper fronts
3174 G. Farren, Brompton—Registering votes
3175 G. F. Parratt, Whitehall—Flexible air-tight cylinders
3176 W. Lawrie, Great Yarmouth—Burning mineral oils
3177 J. H. W. Biggs, Manchester—Joining warp ends

11th November, 1867.

3178 W. Thompson, Dublin—Omnibuses
3179 W. Payne, Birmingham—Pumps
3180 C. B. Hodgetts, Corngreaves—Tuyeres for blast furnaces
3181 S. Buxton and W. Gardam, Leeds—Safety lamps for mines
3182 G. Ellis, St. John's Wood, and M. Jacobson, Spitalfields—Safety desk.—A com.
3183 C. E. Brooman, Fleet Street—Burning and distilling petroleum.—A com.
3184 T. J. Leonard, Castlefield—Rolling iron
3185 W. R. Lake, Chancery Lane—Armour for war vessels.—A com.
3186 W. R. Lake, Chancery Lane—Printing machines.—A com.
3187 W. R. Lake, Chancery Lane—Cartridges for breech-loading fire-arms.—A com.
3188 W. R. Lake, Chancery Lane—Caster for tables.—A com.
3189 W. R. Lake, Chancery Lane—Breech-loading fire-arms.—A com.
3190 W. Campion, Nottingham, and W. Campion, Sneinton—Knitting machinery
3191 F. L. de Gerbeth, Haggerstones—Treating oils and spirits.
3192 G. T. Bousfield, Brixton—Sewing machines.—A com.
3193 F. Ransome and H. Bessemer, Queen Street Place, and E. L. Ransome, Greenwich—Grindstones

12th November, 1867.

3194 J. C. Bayley and D. Campbell, Adelphi—Fire-lighters
3195 H. A. Bonneville, Bayswater—Lubricators.—A com.
3196 H. A. Bonneville, Bayswater and Paris—Pressing bricks
3197 R. P. Faucheux, Kentish Town—Tobacco pouches
3198 W. H. Crispin, Stratford—Artificial fuel
3199 J. T. B. Porter, Lincoln—Rotary digging machines
3200 C. E. Brooman, Fleet Street—Heating apparatus.—A com.
3201 T. Evans, Walsall—Buckles
3202 M. B. Westhead and R. Smith, Manchester—Arranging tapes
3203 A. M'Kenzie, New Bond Street—Opening and closing carriages
3204 L. A. Badin, Paris—Bungs for casks
3205 J. Humby, Liverpool—Compound metallic plates
3206 J. Carter and T. Chalmers, Dunfermline—Details and fittings of windows and doors
3207 J. D. Scally, Burton-on-Trent—Casks

13th November, 1867.

3208 A. F. Gaidan, Regent's Park—Compressed fuel.—A com.
3209 J. W. Lowther and T. Bennett, Manchester—Safety lamps
3210 F. Andrew and E. Whittaker, Harpurhey—Printing rollers
3211 T. Wilson, Birmingham—Breech-loading fire-arms
3212 A. M. Clark, Chancery Lane—Tubular boilers.—A com.
3213 T. Taylor, Bethnal Green—Playing games
3214 W. R. Lake, Chancery Lane—Breech-loading fire-arms.—A com.
3215 U. P. Wurflein, Berne—Joining blind cords
3216 R. Adams, Forest Hill—Breech-loading fire-arms
3217 E. Madge, Swansea—Sulphate of iron.—A com.
3218 E. Madge, Swansea—Feeding metal to rolls
3219 A. V. Newton, Chancery Lane—Rotary engines.—A com.
3220 P. E. Bland, St. Louis—Making bricks.

14th November, 1867.

3221 R. F. Fairlie, Gracechurch Street—Locomotive engines
3222 J. Morrison, Birmingham—Sewing machines
3223 P. De Bavay, Brussels—Attenuating the effect of shocks
3224 G. Kent, Holborn—Kneading machines.—A com.
3225 R. Harrison, Dublin—Cocks
3226 W. H. Richardson, Glasgow—Iron and steel
3227 J. Combe, Belfast—Making cops
3228 L. A. Wainman, Leeds—Raising water
3229 A. M. Clark, Chancery Lane—Applying bronze on paper
3230 J. P. L. Heckmans and F. J. Nunny, Harrow Road—Washing machines
3231 W. R. Lake, Chancery Lane—Steering apparatus.—A com.
3232 J. Clark and A. Esilman, Glasgow—Treating metal and obtaining products therefrom

15th November, 1867.

3233 R. G. Harcourt, Birmingham—Fire-lighting material
3234 P. M. Parsons, Blackheath—Artificial granite.—A com.
3235 G. R. Solomon and M. Bebro, Manchester—Ticket register
3236 J. Crossley, Heckmondwike—Looms
3237 W. E. Gedge, Strand—Gas engine.—A com.
3238 A. Airiau, Paris—Hydraulic clocks
3239 R. Morton, Bloomsbury—Keys for locks
3240 L. B. Bertram, Redland—Tobacco pipe
3241 E. Farrington, Paris—Tubular cannon
3242 R. C. Addy, Belfast—Spinning and twisting frames
3243 A. M. Clark, Chancery Lane—Refining copper.—A com.
3244 J. Templeman, Glasgow—Fire lighters
3245 R. Howson, Middlesbro'-on-Tees—Gas furnace
3246 R. Heathfield, Birmingham—Cut nails

16th November, 1867.

3247 H. A. Bonneville, Paris—Propelling vessels.—A com.
3248 J. Swindells, Kegworth—Treating minerals
3249 R. Holliday, Huddersfield—Cleansing wool
3250 C. E. Brooman, Fleet Street—Ornamenting glass.—A com.
3251 R. Garbet, Walsall—Indoor games
3252 A. V. Newton, Chancery Lane—Securing envelopes.—A com.
3253 F. W. Russell, Stoke Newington—Cask stands
3254 C. Ritchie, Brixton—Brushing and Perfuming hair
3255 R. W. Pearse, Greenwich—Pianofortes
3256 J. E. Richter, Brunswick Square—Breech-loading fire-arms
3257 J. M. Napier, Lambeth—Printing calico
3258 W. R. Lake, Chancery Lane—Covering buckles.—A com.
3259 W. Bailey, New York—Ornamenting paper hangings
3260 J. G. Tongue, Chancery Lane—Refining wines.—A com.

18th November, 1867.

3261 L. and W. Brierley and J. Bonnell, Warrington—Waggons and other carriages employed on railways
3262 R. Husband, Manchester—Hats
3263 E. Lord, Todmorden—Cleaning cotton
3264 C. E. Brooman, Fleet Street—Furnaces
3265 E. T. Hughes, Chancery Lane—Knitting machines
3266 W. J. and J. Busfield, Bradford—Preparing wool
3267 W. J. Hanson and J. C. Ellison, Rawfolds—Dyeing textile fabrics
3268 J. V. Thornton and C. Abercrombie, Brighouse—Twisting yarns
3269 J. Colebrook, Queen's Terrace—Butter basket
3270 G. Fitt, Limehouse—Artificial manure
3271 K. J. Winslow—Conveying rotatory motion to axles
3272 T. Wood, Chester—Lamps

THE CLOSE OF THE GREAT EXHIBITION.

THE GREAT LESSON—EDUCATION.

THE great Exhibition is amongst the things of the past. Punctual to the day named some few weeks previously in the *Moniteur*, though contrary to the hopes and wishes of many and the expectations of a few, the grand pageant reached its close: for we cannot regard the three additional days, Friday to Sunday inclusive, during which the time was nominally assumed to have been extended, as any real prolongation; for the work of demolition had already commenced, and the diurnal order of the great machine had ceased at a thousand points to revolve with its wonted regularity and beauty.

The final departure, however, from the precincts upon the late gray afternoon of Sunday, the 3rd November, when for the last time the daily tatoo of the drum for breaking up, was heard resounding from the central garden, was not without a solemn sort of significance that visibly, as well as audibly, if we may apply such an expression to the unwonted silence of a great Parisian crowd, made itself felt everywhere. During the whole week or so before, one seldom met acquaintances or well-remembered official faces in the *parc* or building, without hearing some word or sentence, or perhaps a mere gesture, expressive of regret. All around awaited quick dispersion, and as a whole, irreversible dissolution, and the feeling was not even to the stoic and realistic Americans without a tinge of melancholy; far more so to those of more imaginative mould, and who saw, or seemed to see, *cito peritura* written in the air wherever they might turn.

There was no "closing ceremony," and so best. The emperor, as a discerning man, is not overfond of religious clap-trap at any time, and both he and the hierarchs of the Gallic church in Paris have too much good taste and good sense not to see the monstrous incongruity, not to press upon the hypocrisy and cant with which it might be charged, of solemn pretences to Hallelujahs and thanks to Almighty God for the safe conclusion of what, viewed in so awful a light, is no more than the closure of a good balance sheet in a factory, or a prolonged and in the end satisfactory speculation on the Bourse. There was, hence, none of that which in 1862 intensified the odious aftertaste of all the blundering bad taste, the greediness without guiding, the small jobbery, the left-handed capital-making, of the mismanagement of our ever memorable 1862, by its concluding psalmody and benedicites.

Perhaps the French had this still fully and forcibly in remembrance; and if their executive did commit a few things not very defensible, as to chairs and other less nameable conveniences, probably they resolved not to add a piece of solemn humbug to the catalogue of their sins. However it was brought about, there was no ceremony at the close whatever, not even such as the presence of the emperor, or even of the chief commissioner, would have amounted to. There *was*, however, a spontaneous emphasis given to the actual closing scene, that, as we have said, none—certainly none from England—present had anticipated. Probably on no one day from the April morning on which the Exhibition opened, forwards, was there such and so large a gathering of people present in the building particularly, but also in the *parc* and in *its* buildings, as had collected on Sunday from about noon. The two preceding days had seen the building comparatively empty, for news does not travel in Paris at the rapid rate it does in London, and the stringent tyranny over the press in France makes every editor mortally afraid of the possible penalties for propagating false news, if he print rumours, however publicly interesting, which may prove erroneous, if even with the mystic *salve sis* tacked on of *avec beaucoup de reserve;* and so the *fact* that the Exhibition, if not open, would be enterable for the three last days of the week, was not very generally known in Paris until Saturday had reached its waning hours. But on Sunday, to the usual fête-day sight-seeing and in fine weather, was added the desire to see what could be seen, but then again once more and nevermore; and so the gathering, not of the upper ten thousand, of those there was but a sprinkling, but of the great middle and better part of the working classes (as they who earn wages are called), the crowd was enormous. We have heard it estimated at 300,000; it was probably much short of that, but still a vast multitude. It was indeed the only occasion upon which, during the whole year, we remember to have seen the great central straight grand avenue, reaching from the Pont de Jena up to the grand northern entrance to the building, densely and inconveniently crowded.

Standing about five p.m. at that grand entrance, and looking down over the full width and length of that grand promenade, and over the whole beyond the bridge, to the giant staircase of the Roi de Rome at the opposite side of the Seine, one saw but a densely packed and slowly restless rather than moving crowd of men and women. But while the evident aim and tendency of the whole huge column was to break off at its further end, deploy and dissipate itself upon the bridge and quays, as homeward compelled and bent, it was a striking thing to see that the vast majority of the upturned faces were looking back upon the building, and not forwards towards the way in which they slowly and haltingly tended. It was a vast multitude with one dominant thought, the wish "to cast one longing, lingering look behind;" nor as one threaded his way through the throng towards the final exit, could the universal sentiment and the subdued expression of a sober regret fail to be heard on every side around; it has passed, a beautiful dream, an intensely vivifying reality, a prophecy to those who have seen the vision and used the reality, and are fitted to interpret them aright.

It was a prevalent notion, amongst the English at least who were in Paris—and some arrived there with the special object—that after this closing day would be the time to look out for bargains, and to make purchases at the suggestions of science, taste, or gain. Nothing proved a greater mistake, however. All the best things had been quietly sold long before; and while *vendu, vendu*, met the eye in all directions, over many of the collective exhibitions not sold, no *gardien* or proprietor any longer presided, and as to these no information often could be got.

In 1862 tons of more or less interesting mineral and other specimens were given away and carried off by the often lucky recipients. Minerals and metallic products, now and then of great rarity, as of Hungary, Styria, Spain, Australia, Canada, and Russia were had for asking for them. The grand mineral and metallurgic display made by Prussia was, we believe, given *en masse* to South Kensington, and, it is stated, was stowed away in damp cellars or rooms, and let to become destroyed by rust and dirt. The case was, from whatever causes, widely different here. Everything not sold was rapidly and carefully guarded and packed up, and prepared for return whence it came.

From the great Prussian collection the writer found some difficulty in procuring a single specimen of an ore of lead from Eastern Westphalia, in one of its most singular geognostic forms, viz., crystals of galena, uniformly *parsemé* in a massive rock of soft, friable, white sandstone. Some of the very finest of the mineral gems (beryl, topaz, tourmaline, amethyst, sphene, peridot, &c.) produced by Russia have been purchased for our British Museum. Of the characteristic Russian painted glass vases and vessels not a single good specimen was left.

Some of the French national collections have received some valuable additions by purchase (among these, the Conservatoire des Arts et Métiers); and although the precise nature of the purchases made by South Kensington with its very moderate residual fund is not yet known, one of its acquirements, namely, a very fine collection of exhibited educational models of mechanical combinations for teaching kinematics and the organology of machinery, purchased provisionally from J. Schröder, of Darmstadt, cannot but prove of service hereafter, though we hope in better ways than merely occupying glass cases at South Kensington.

The Great Exhibition has been the event of the year, which itself now draws rapidly to a close. To the million it has been probably not much more than the excuse, or at best the centre of attraction, that has drawn them to Paris. These were they who were represented, as the wags had it, by the outer zone of eatables and eating, drinkables and drinking, Hebe'd and helped by *cocottes* of all nations; and certainly some portions of that outer zone, especially towards the Porte Suffren at one side and Mr. and Mrs. Chang at the opposite one, were the only blots upon arrangements which everywhere else avoided the sordid small traffic and the tumult and meannesses of the veriest country fair, there daily seen and heard; indeed, which was far below the level of a decently good German kermes. To thousands the Exhibition, in its central garden and two surrounding zones, the *Histoire du Travail*, and the picture and sculpture galleries, was a shrine of art, a delicious daily lounge for those who could afford the time—a beautiful and bewildering phantasmagoria for those whose week or fortnight slipped away and proved all too short. To still fewer, the great machinery zone, and that of primary productions or raw products, as we call them, was a mine of thought and of information that seemed more and more inexhaustible the longer it was dwelt upon, and the more fully its riches were rendered familiar and accessible by habitude and daily converse with them.

Those who thus individually profited most by the Exhibition—and they were very few who could profit very effectively by it, unless those whose professional connection with it, or their avocations in some way, gave them some *months* to study it—have, so far as we can learn or observe, come to one view as to the inadequacy of the means provided at all these Exhibitions for thoroughly examining or studying anything in them.

This is the true history of all the dissatisfaction shown, and in some cases loudly expressed, and most justly, at the unfair or undiscriminating rewards bestowed on the one hand, and the passing over or withholding of well-deserved rewards on the other. The so-called jury work was so pushed, so urged on to "keep time;" the apparatus of examination was so inadequate, the mass to be examined so vast, the means of experimental trial so totally wanting—that the results were all mere hap-hazard. The sense of this on the minds of jurors soon gave rise to that of scramble, and of the idea on the part of jurors of each nationality to secure more or less of the good things for those whom they deemed most deserving in their own compatriots. With every desire to do their duties honourably and conscientiously, it was pretty plain that, with all the more important juries at least, the attempt soon seemed hopeless.

This Exhibition has been so vast, so full and complete, that possibly at least a decade may roll away over all Europe before any attempts will be made to rival or repeat it anywhere. We hope and wish it may be so; and are quite clear that it will be to the interest of exhibitions and exhibitors, and of all that the latter most value, that it should be so. But even already there are mutterings of others in prospect; and as exhibitionizing has really lost its early aim and significance, and descended in certain aspects into a trade, we much fear that not even five years will pass without another display somewhere in Europe. It is every way to be deprecated by those who stand aloof from the mere trade of getting up and keeping up these mighty shows. Their too great frequency begets some of the worst consequences belonging to them. There is no denying that this Paris Exhibition was a bit of trade in the Emperor's own way. True, the *time had come* for holding some sort of exhibition of the decennial progress of *French* manufactures; for that is what has really descended on France from the days of the First Empire decennially to do. But the *times* in various political aspects made it expedient and politic that the imperial government should make this an *International* Exhibition, and a very great affair. Nothing almost could be abler and better than the way in which this was carried out, and the chief real aims of such exhibitions harmonized with a display, such as should gather kings and potentates, make Paris for a time the world's centre in the eye of Parisians, and deaden the unpleasant remembrances of the Mexican misfortunes, of the unification of Germany, and of other minor griefs.

But yet, however well done, the mixing up the motives for such exhibitions with political objects is not legitimate, nor likely to be without a bad effect. If there *must* be for secondary objects a very grand show, exhibitors must be coaxed and induced. Their presence in sufficient force and number must be insured, and one of the ways of effecting this is by a lavish list and scale of rewards, as well as by offering inducements more directly addressed to the pocket. It would probably be unwise and unfair to abrogate all medals or rewards, as has been proposed by many; but if they are to be retained, they should be awarded far more sparingly and far more searchingly. Perhaps their limitation to a *very few gold medals* in each class, allotting a certain maximum number to each nation in each class, would be the truest method. These medals should only be awarded after a scrutiny of a very different sort from the hurried and random-shot examination that hitherto has decided the prizes.

But then, are all the others, the immense mass and majority of the Exhibition, to go empty-handed away? No; but let their merits also be appraised more rigidly and fully, and stated to the world with a sanction that, if deserved, would be worth more than a string of medals such as are now given. Make the reporting, not a sham, but a reality; organize such an efficient staff of competent men as may be necessary, pay them liberally, make their time and attention compulsory, provide them with fitting clerks and rooms for studies, and give them ample time for the production of such reports as shall not only fix upon and record all that is less or more worthy, on the part of exhibitors as shown by their works, but that shall make the record of these works permanently valuable to the exhibitors and to the world at large.

As heretofore conducted, not one tithe of their value is extracted from Exhibitions. An enormous proportion of the material brought into the huge display is never seen at all to any good purpose: it comes and goes, and leaves as little behind as writing upon sand. What is seen most, is very often not what most deserves to be seen, and what least challenges general or often even special attention, is in some cases that which is destined ere long to prove itself of world-wide value and importance. After the whole display is at an end, nought remains but a confused image of but little value, and ill capable of being compared with the still more confused and blurred image of the Exhibition that went before it.

And the Jury Reports, nor any of the reports in the style yet produced, don't make this much better. Many of these reports are little better than diffuse and bad catalogues; almost none deal with their subjects from the lofty platform of thorough knowledge, antecedent as well as obtained by examination, needed to make them lights and guides to future progress and improvement. There will be a report, no doubt, to take an illustration, from a jury—*i.e.*, from some dozen or twenty men, with no one in particular responsible—upon the "Instruments of Precision," or, as we should call them in more old-world phrase, "Philosophical Instruments." What will it teach any one already moderately up to the subject, and interested in it? Will it tell us, amongst all the theodolites, for example, shown, which was the best, and why; and justify the judgment by giving, lucidly and briefly, what are the conditions to perfection in such an instrument on fundamental principles, and show that the judgment is just by producing experiments of angular measurements made in verification of the actual instrument? Yet this is just what a Tyndall or a Jamin would do were it the duty of such a man to report, and that he individually were made responsible, as he would be, for a report coming from under his hand.

Not only is this better sifting of the chaff and wheat of exhibitions wanted to give them their highest value, but a more complete and permanent record of all that is exhibited. Much more might be done hereafter to make this perfect. Every object susceptible of it that comes into and is granted space in an Exhibition, ought, as a condition, to be accompanied by such a set of photographs, and such a written description, prepared by and at the expense of the exhibitor, as certain examining officers should deem amply sufficient, prior to granting authority of admission. All not susceptible of visible representation should be nevertheless fully and accurately described. These descriptions might, in part, conform to certain general normal types. Exhibitors of machinery or apparatus ought to be required to produce with their objects accurate sets of drawings, plans, sections, elevations, details, made also on normal types, and prepared for engraving. Exhibitors who declined to give these should not be admitted.

With such a mass of reliable information to start with, jury work would be comparatively easy and sure. But experiment, and the means to it, should be added. The chief attempts at this in Paris were the British Testing-house (so called because in it nothing was tested, except some cooking apparatus and gasfittings, &c.) and the chemical laboratory in the French Department on the Seine Quay, in which we are not aware that any one train of experiment in relation to the Exhibition was even attempted. Some steam fire-engines were rather loosely tried against each other, but how little else. Yet here were scores of steam-engines *at work*, and from which rewards were withheld or to which they were given; and, with the exception of the Allen Engine, to which Mr. Porter, its representative, kept an indicator continually applied, and ran off cards for any one who asked for them, we do not think there was another engine in the entire Exhibition as to which anything like an experimental determination of the relations between duty and useful and useless work was applied. So also by the fire-engines, the pumps, the blast fans, and plenty besides.

Such as it was this Paris Exhibition has in one respect been of inestimable service to us British, in having forced upon us a more or less distinct knowledge of our deficiencies, and a greater respect for the powers and progress of other nations.

Should the feeling, so general, and upon the whole, whether exaggerated or not, or partially based or not, yet so well founded, result in any comprehensive, courageous, and well-considered measures for the improvement of education generally in our country, and more particularly amongst its wage and lower classes, we may bless the day the events of which forced upon our apathy the conviction that such might no longer be safely omitted or delayed.

No more hopeful beginning, perhaps, could have been made to this,

than by the resolutions which Lord Russell moved that they should be those of the House of Lords, on the 2nd December last; but Lord Russell's singleness of purpose was not believed in, nor was his own knowledge of his subject complete. Technical education, about which so much is talked, and in many quarters so ignorantly, is of no use without primary education. In more exact terms, education must precede information. The very first step wanted is that expressed in Lord Russell's last resolution—appoint a minister of education, abolish the unsymmetric and unworkable absurdity that the education of a great people should be intrusted to a back-stairs' office, tacked on to the Board of Trade. Make primary education compulsory: listen to no unreasoned and unsupported dicta, that English feeling, &c., won't stand that. The *feelings* of those who would rather gain a shilling a week from the labour of a child of nine or ten years old than permit it to learn to read, are not to be talked of with patience. Those of creeds, and clericy, and bigots of whatever sort, the upshot of whose piety is, that rather than the child shall learn any other doxy than their own pet one, it shall learn nothing, not even to read, are not to be tolerated. Let us calmly, fully, and well consider *how* we may best do it, how we may best make it fit our social and other conditions in Great Britain and Ireland; but let it become a principle of our constitution and law, that no child shall be permitted by the state to grow up ignorant of the rudiments of such common knowledge, of such training of mind, as shall fit it to become a decent man or woman, at least shall avoid its becoming a useless or a bad subject in the commonwealth. With such, and so much of knowledge, let neither priest, parson, nor minister interfere in way of possible hindrance; that is to say, not interfere at all, because any such interference as by the very nature of things these alone are likely to effect, must be in the way of hindrance.

The great outlines of the proper connection between moral teaching, religious observance, and such primary secular education, are already to our hand in the models of Prussia and elsewhere. Few in England know anything almost about what these are, though many are ready to affirm that they are inapplicable amongst ourselves.

Furthermore, provide adequate apparatus and enactment as to the education of girls in the lower ranks. Bad as female education in every rank is in our country, superficial, flimsy, deceptive, and absurd as it is even for the upper classes, as respects the very lowest labouring class of girls both in town and country it can scarcely be said to exist. The girls grow up into women, who become mothers, and of their sons our working men are made. What is to be expected but violence, and savagery, and murderous trades unions, from those reared at the knees of women who, in vastly too many instances, are nothing better than so many breeding animals? mothers whose own conceptions of social relations, of moral duty, are so dormant, or so warped from what in better light is deemed good and true, that the earliest teaching of the child differ in almost nothing from what it might receive from a Red Indian or an African mother; with whom to repel injury, or disappointment, or violence, by violence, is the only notion of manhood or of redress inculcated, if the child be the stronger party, or if the weaker, lying and cunning as its defence.

What can be expected, or hoped for, when such children grow to be men, but that their only and instant idea, if they imagine an employer injures them or tramples on their notion of right, is to seize him by the throat; or if the *repressive* violence of the policeman obstruct this, then to blow up the employer's works, or his offending workmen? A distorted perception of his own *rights* is keen and lively, as every other selfish passion, with such a man; but any notion of *duty* corresponding on his own part is dull or wanting altogether. This is no exaggerated picture of the state of moral and social and intellectual culture of some millions of our population in the hives of industry, as they are called, and equally in the agricultural regions of our island; the main differrence, as regards the labouring population of the latter, is, that all the reckless daring and self-dependence of the manufacturing population is ground out of the agricultural one by the steady pressure of landlordism, if by that one word we may endeavour to express the resultant effect of that system of society in English country places, which has descended from the feodal system, and the ecclesiastical one of a later age—one which looks superficially so fair outside, but within which there is so much hollow and rotten; so little capable of elevating or ennobling the peasant race, so much to debase and morally emasculate it. It is, whether in the said hives of industry, or where the lark sings over till and lea, a lamentably poor result of the assumed mission of all the church apparatus, Established or otherwise, which for above three hundred years has boasted of its purity and power, and called itself Reformed. The remedy, however, neither lies *now* no longer in the church or with the church, neither in "church accommodation," nor in "extension of the episcopate," nor any like dishonest pretences. The people, the populace, in these countries have passed utterly out of the grasp of the church, unless possibly for occasional spurts of rancorous bigotry and mutual theological hatreds. Religion either has no active existence or it is a mere creed more or less dim, but dissevered from morals and powerless for good.

How this has come about—of course we do not expect "good churchmen," whether lay or cleric, to admit that it has come about at all — what have been the great confluent causes that have led us to such a pass — it would be too long and be out of place for us to here attempt to show. It is not *all* the fault of the church, but it is utterly beyond the church's power now to alter, much less remedy. In only one way can the ecclesiocracy, which we designate the church or churches, now help to alter or amend it; and that is, by standing aside and abstaining from throwing the obstacles which are always too ready to their hands, in the way of that free and unobstructed primary education which should be made compulsory with respect to all children up to the age of fourteen. To effect this would be to begin at the foundation, and within a generation, say thirty or forty years, the building of knowledge, both in head and heart, would begin to show its reality and symmetry. To ignore and neglect it, and be content at most with founding technical schools, or giving more money and scope to South Kensington, or such like lame and featureless things, will merely be to make matters worse than they are. The tree must be made good from the very roots up, if the fruit is to be good. Meanwhile, however, there are hundreds of thousands who, through one or other sort of luck in antecedents, have picked up a fair amount of primary instruction, and hunger and thirst for some better teaching than our middle-class schools, in one wide word, our entire educational apparatus as existing, is competent to supply. Here, and for these immediately, we want the formation of British ectypes of the lyceums, the normal schools, the gymnasia, of France and Germany. Between such schools, not of specialized but of general knowledge, and our three great universities—Oxford, Cambridge, and Dublin—there are wanted some colleges, based mainly upon the characteristic *curriculum* of the greater part of the German universities; colleges in which mathematics, physics, chemistry, all, in fact, that constitutes the *laws* of the world we live in, should be taught mainly. There are a few existing institutions doing little good for the most part, which, so far as they go, might be remodelled into these; but one such college, at least, should be found in every shire in Great Britain. Law, theology, medicine, surgery, or such specialities, should be excluded, and have their own proper homes. Let Oxford, Cambridge, and Dublin remain without much interference; their systems have moulded and hardened during centuries into a something unsymmetrical and shortcoming enough, for all but a few who would come to the front irrepressibly and anywhere, but which gives a sort of tone, and education not without value, for heirs to wealth and land, for all who ought to be in all other respects also the genuine *αριστοι* of a country. But one great change these old universities must submit to, and speedily, if they are not ultimately to drop astern of the world's progress, and get to be as effete and powerless as the church itself which they educate. Some one-third of their "good things," of their revenues and rich endowments, must, as death and other circumstances shall allow, be diverted from their far too numerous and almost, if not altogether, unnecessary professorships of classical or other cognate knowledges, and applied to the foundation of new professorships of physics in its many branches, physical geology, the higher mechanics, applied mathematics, theoretic chemistry, and much of the sort, the high-placed and pure fountains of natural philosophy in its largest sense.

With such an apparatus in good work amongst us, then indeed we might expect real and striking results from the working of an efficient system of technical schools, which without it can do little more than keep up a deceptive sort of goose step. Of what use, to shorten what we have to say by taking an example, would be a technical school of civil and mechanical engineering if the students who enter it have acquired no sound knowledge of elementary mathematics? A competent and practical engineering professor, we will suppose, begins to lecture his class upon the theory and practice of iron-girder bridges; but he at once finds out that his hearers have no clear notion of what

a moment or a couple mean, or if they have, that they cannot deal algebraically with the one or the other. He treats of strains in framing, and he finds that his pupils have never received any distinct or available knowledge of molecular physics or of trigonometric functions. What is the lecturer to do? he must either turn to and teach them these things hurriedly and imperfectly, and thus drop altogether technical teaching for mere rudimentary education; or go on lecturing to those who gather no more good from it than they would if he talked in the unknown tongue, which is just, in fact, what he does talk *to them*; or he must descend from being an exact and worthy teacher of the laws of the technical subject upon which he treats, and in reaching the level of his classes' ignorance, become useless if not injurious, as a teacher of smattering and ill-based dicta.

More or less this is just the state of things that at present would meet every professor of technical knowledge in any department in Great Britain; and therefore it is, that as regards the more advanced and intellectual classes of the community, as well as those who are to earn their bread by the sweat of their brows, we say—our national reform of education, if to be at all, must be thorough, and must begin at the very roots. It must do so as regards those of the upper classes, because without a foundation no superstructure of knowledge of a stable and valuable sort is practicable: for them it is mainly a question of head. As respects those of the lower classes, it is not alone one of head but also mainly of heart, and without *some* previous culture of the head, any teaching of the heart is impossible.

What should rightly constitute the framework of future technical schools throughout our country, we shall not at present and at the end of an article consider. It must be one, however, far more widespread and comprehensive than, so far as we can see, people generally have any clear notions of. We shall probably return to this branch of our subject, than which there is not one of greater import to us nationally to well consider, and promptly and energetically and *honestly* act upon.—Ed.

ON SOME POINTS OF PRACTICE IN IRON FOUNDING.

No. XXIII.

American Gun Founding.

In America the samples of iron were tested for permanent elongation by three different methods, but all were indirect. The first consisted in the observation of the deflections of bars supported at two points. The second, in observing the angles of permanent torsion assumed by bars submitted to a definite force of torsion; in the third, the permanent compression was observed in bars subjected to determinate pressures. But these experiments gave no positive results, owing to the smallness of the magnitudes measured, and to the considerable influence of small errors. Yet it appeared in most cases that the capability of receiving permanent elongation diminishes in proportion as the iron is whiter, but there were so many exceptions to this rule that nothing can be regarded as certain. Still, if we remember that very hard cast iron is also very brittle, we may take it for granted that white iron does not possess the property of taking permanent sets to the same degree as less harsh samples. As to the property of contracting in cooling, it is known that this is more observable in white than in gray cast iron.

We have seen already that the density and tenacity of iron increase by prolonged fusion, but that iron becomes harder and whiter; thus the two properties of which we have just spoken, and which must be considered as injurious, also increase. We can thus understand that there may be a limit beyond which these properties may have a greater increase than that of the resistance of the metal; so that the cannon cast of such will become weaker and weaker. The results given in the table show that this limit was often passed in the American experiments of 1844 to 1852.

We have already stated that a density of 7·275, and a tenacity of 30,000 lbs. per square inch, were the limits which determined the guns of the first class; all the cannons then, the metal of which possessed at once a greater density and a greater tenacity, had to be placed in Class 0. It is remarkable that this density is the same that corresponds to the maximum resistance of the Greenwood iron cast into test bars. From a theoretical point of view this relation between the bars and the cannons is easily explained. During the cooling of the bars the same effects are produced as during the cooling of the guns; the bars are consequently composed of an infinite number of layers, each of which had, at the moment of solidifying, a temperature higher than that which immediately preceded it, and thus the same internal strains would be produced as we have seen in the case of the double bar, which we have already adduced as an example. It is probable, then, that the maximum resistance of the test bars corresponding with a certain resistance, may serve as an index to the resistance of the cannons, by determining the limit which the density and tenacity of the metal of which they are made should not pass.

We have already remarked certain exceptions to the rule which consists in judging of the resistance of guns by the density and tenacity of their metal, and we believe that no doubt can remain that these exceptions are due to the controlling influence of the two injurious properties which we have mentioned. It is of considerable importance, then, to know exactly the degree of influence which these two properties have on each gun, and the more so since by a judicious combination of these properties, the injurious influence of one of them may be considerably lessened. For example, if the metal of a cannon contracts considerably in cooling, but that this metal be capable of assuming considerable permanent sets, the hurtful influence of the first property will be counterbalanced by that of the second. During the cooling of the gun the internal strains are certainly produced; but the interior layers, constantly stretched by the resistance which the exterior layers oppose to their contraction, yield little by little to these strains, and their elongations become in great part permanent, that is, non-elastic, so that the internal strains existing in such a gun disappear after a certain time.

This is the same phenomenon in kind as is observed in an iron wire to which a weight is suspended, and which continues to stretch for years together. Another phenomenon which approaches still more nearly to the case of cast iron is that which glass presents, which, when cooled quickly, becomes excessively brittle in consequence of the internal strains which are produced, but which, when afterwards exposed for a sufficiently long time to a slightly elevated temperature (even if not greater than boiling water) gradually becomes less harsh and brittle, in consequence of the reduction of the internal strains. It is conceivable, then, that if the internal strains lessen with time, a cannon where these strains exist should offer greater resistance if proved after a certain lapse of time, than if proved immediately after completion. The American artillerists appear to be convinced of this influence of time; which, for that matter, is corroborated by the following table:—

No in order.	Nature of Piece.	Class.	Time which elapsed between Casting and Proving.	Specimens.		No. of Rounds Fired.		Guns which did not burst.
				Density.	Tenacity.	Increased Charges.	Service Charges	
1	8-in. Columbiad. No. 3,	0	80 days,	7·288	37,984	73	—	—
2	" " No. 1,	1	34 "	7·221	27,014	85	—	—
3	10-in. " No. 5,	0	49 "	7·290	37,989	20	—	—
4	8-in. " No. 64,	1	100 "	7·276	26,367	729	—	—
5	10-in. " No. 67,	1	100 "	—	—	600	11	—
6	32-pounder,	1	100 "	7·271	33,590	1000	6	—
7	8-in. Columbiad,	1	6 years,	7·247	29,423	2582	—	1
8	" "	2	6 y. 44 d.	7·220	22,989	800	—	—
9	" " No. 19,	0	6 years,	7·333	36,496	500	11	1
10	" " No. 23,	1	7 "	7·277	26,837	500	4	—
11	10-in. " No. 1,	0	6 "	7·298	33,344	94	—	—
12	" " No. 2.	1	7 "	7·416	29,181	500	9	—

The first glance at this table shows that a certain interval of time between casting and proving exerts a favourable influence on the resistance of guns. Yet, to arrive at reliable conclusions, it is indispensable to compare the guns of the same class only. Pursuing this method, we see that four guns, Nos. 1, 3, 9, and 11 of the table, belong to Class 0, No. 8 to Class 2, and all the others to Class 1.

Among the cannon of Class 0, two were proved a few days after casting, and showed but little resistance. The two others were not tried till six years after casting, and one proved very strong and the other weak. It is remarkable that these two guns were the only ones (see table) proved a very long time after casting, and that No. 9 is also the only one of this class which withstood a severe trial. The great resistance of No. 9 is explicable by the transformation of the elastic changes of dimension due to internal strains into permanent ones, from the effect of time; and the weakness of No. 11 by the continuance of the internal strains, the metal not having the faculty of taking permanent sets. Among the guns of the first class, one only showed itself weak, namely, No. 2, proved thirty-four days after casting. Among those

proved 100 days after casting, one only, No. 4, showed weakness; the two others, Nos. 5 and 6, underwent a severe proof. But it is to be remarked that No. 2, which, according to table, is the only one of the first class which burst after a few rounds, is also the only one which was tested a few days after casting. As to No. 4, which burst at the 729th round with a service charge, the proof took place 100 days after casting, as we have just said. It is very possible that these two guns turned out weak in consequence of the internal strains not having had time to assume a state of equilibrium.*

We thus have the two exceptions to the general rule which we established in analyzing Table XXII., namely, a gun of Class 0 which proved very strong, and one of the first class which proved very weak. The first was not proved till long after being cast, and the second a few days afterwards. Nevertheless, the preceding table proves that if time has an influence on the resistance of cannon, the classification which we have adopted for Table XXII. is no less founded on reason. Thus we may quote No. 11 of Class 0, proved six years after casting, and which notwithstanding turned out weak; while Nos. 5 and 6 of the first class, tested 100 days after casting, proved very strong. We may conclude from this that time does not always improve cannons of Class 0, while a short time suffices to influence the resistance of guns of the first class.

If the internal strains diminish with time by the transformation of elastic into permanent changes of dimension, the same effect ought to be produced much more rapidly when the metal is maintained at a high temperature. Hence in America it is attempted to delay the cooling of the guns after being cast. For this purpose they are allowed to remain several days in the pit before being taken out of the mould.

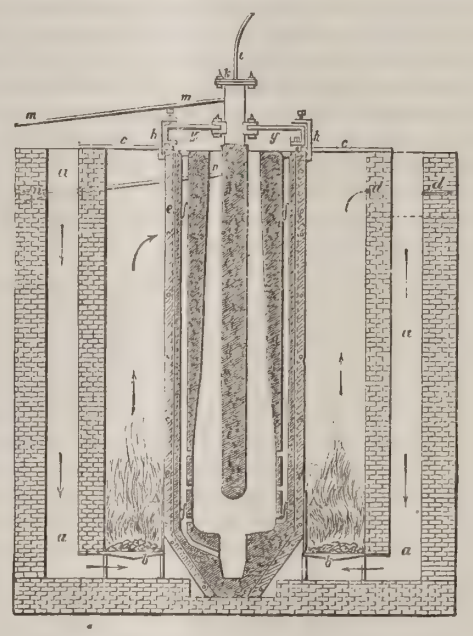
To test directly the influence of gentle cooling on the strength of cannon, there were cast at Boston, in 1847, two 6-pounders from the same furnace. One was cast in the ordinary way, and the other in a mould heated redhot by means of a fire made round the moulding box. This fire was kept alight for three days, and it was then allowed to go out gradually. At the end of the fourth day the cannon was withdrawn from the pit, and on the fifth day it was stripped from the mould. These two guns were proved with extra charges:—The first stood twenty-five rounds, two of which were with the maximum charge of 3 lbs. of powder and sixteen balls; and the second twenty-seven rounds, of which four were with the maximum charge. Although firing with extra charges gives generally but inexact indications, this difference gives decided evidence in favour of gradual cooling.

New Mode of Casting.—We have seen that one of the principal causes of weakness in cannon, even when the metal is very tenacious, rests in the internal strains which are produced when the cooling takes place from the surface of the gun. It was this which suggested the idea to Captain Rodman of the American artillery to cast cannon round a hollow pipe, traversed by a current of cold water, while the barrel remains heated by a fire lighted at the bottom of the pit. By this means the cooling commences at the interior pipe, and the outer layers are the last to solidify.

It is clear that by this process an exterior layer attaches itself to each cooled and partly solidified layer, which produces the same effect as forcing on each inner layer an outer layer previously expanded by heat. When all the layers are cooled down to the same temperature the inner layers are compressed by the outer ones, and this acts in the same way as rings forced on, so that a gun made in this way can be of very great strength. But error in the contrary sense must be avoided here, for if the compression of the metal by cooling be such that the outer layers are stretched to near their rupturing point, it is evident that the cannon will burst (beginning at the outer rings) before the inner rings shall have been able to exert their whole resistance. Yet we must add, the degree of compression which would be injurious in guns cast solid would still have a useful effect in those cast hollow: whence it follows that the second mode allows of the employment of whiter iron than the second, so long, be it understood, as a certain limit be not exceeded.

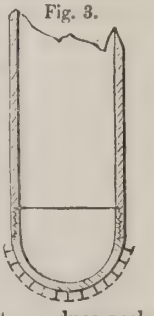
The first hollow guns were cast at Pittsburg in 1849. The following is a summary description of this mode of founding; referring to fig. 2, a vertical section of pit and mould, &c.:—The pit has the necessary dimensions for holding a single moulding box; it is built of brick, and in its walls are two vertical channels, *a a*, fig. 2, which communicate

Fig. 2.



with the foundry, and which serve to lead the air under the grate, *b b*, arranged a little below the bottom of the pit and round the moulding box. The space between the moulding box and the sides of the pit is covered with cast-iron plates, *c c*, and the upper part of the pit communicates by a channel, *d d*, with the chimney of the reverberatory furnace where the melting takes place, so as to produce the current of air necessary to urge the fire arranged round the grate, *b b*, immediately after the casting. During the melting of the metal the channel, *d d*, is closed by a register, to prevent the current of air coming from the pit interfering with the current of air in the furnace. The plates, A A, serve to protect the moulding box from the immediate effects of the flame. The dry sand moulding box is in the form of a cylinder, terminated at the bottom by a truncated cone, and is composed of two half boxes joined by means of the lugs, *e e*; these two half boxes are pierced with holes, to facilitate the escape of the gases. In the sand, which forms the mould properly so called, are two canals, *f f*, serving as siphon gaits for pouring. These siphon gaits communicate with the interior of the mould by means of several openings, arranged at different heights round the barrel of the gun. When the mould is filled up to the level of one of these openings the metal runs through this opening, and ceases to run through that below it; this arrangement is designed for filling each part of the mould with the desired quantity of metal. The coolest iron forms the lower part of the cannon, because this part being the thickest, it is proper that the metal in it should be less hot, so as to cool as nearly as possible in the same time as the other parts of the gun. The mould is filled by siphon gaits as high as the trunnions, and then by the upper opening in the mould by a funnel, so as to produce such a circulatory agitation in the metal as will prevent impurities from lodging in the trunnions. The core barrel is of cast iron, half an inch thick, and slightly conical; its radius diminishing $\frac{7}{8}$ of an inch in its whole length. Into its lower end is screwed a hemispherical closure, the surface of which is studded over with nail-heads, or fixed "gaggers" in British moulder's language, the better to hold the loam with which it is covered (fig. 3). The core barrel is turned so as to give it its exact dimensions; its surface is then channeled with longitudinal

Fig. 3.

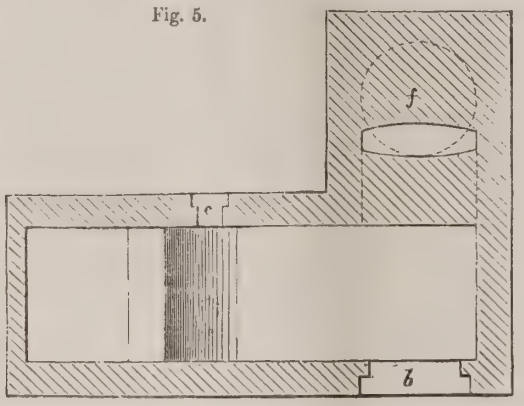


* The American experiments in this table, and as here adverted to, add somewhat to the evidence already pre-existing as to the fact, that the internal strains due to contraction in cooling do gradually lessen and tend towards zero by simple lapse of time, the particles taking gradually such new positions as are necessary to neutralize those constraints.

There remains but little doubt of the general fact, though much remains to be desired to complete our knowledge of the subject, as one of molecular physics. But there is nothing new in the matter as brought forward here by the American experimenters. It has been noticed, again and again, that old guns long in store have more endurance than like guns cast recently; and every iron founder knows that when castings, of whatever sort, fracture through internal strains after they have cooled down to atmospheric temperature, they do so, if at all, very soon after they have so cooled.—Ed.

grooves, to facilitate the escape of the gases. To make the core, a hemp rope of ¼ inch diameter is first coiled round the iron body, and then a layer of moulding loam of ⅞ inch thick is put on. This operation is done in the lathe used for making loam moulds commonly. A represents a horizontal section of the core in this state. The core is then dried at a temperature which does not char the hemp cord, after which the finished diameter ought to be one inch less than that of the calibre of the piece. To fix the core in position after putting it in place, the following methods are adopted:—The upper part of the core is received in a collar forming the centre of a tripod, *g g*, the feet of which, twice bent at right angles, and furnished with adjusting screws, rest on the upper edge of the moulding box when the core is lowered into the mould. The collar is stopped by an edge on the core barrel, and fastened by tightening screws. When the core is lowered into the mould the distance from the sides of the mould at top and at bottom is measured, and it is placed concentrically by means of adjusting screws; the tripod is then fixed on the moulding box by means of three stirrups, *h h*. The upper extremity of the core is closed by a cover, *k*, fixed by screws, and through it passes the pipe, *i i*, which descends into the core to within 2 inches of the bottom. The upper part of this pipe opens into a

Fig. 5.

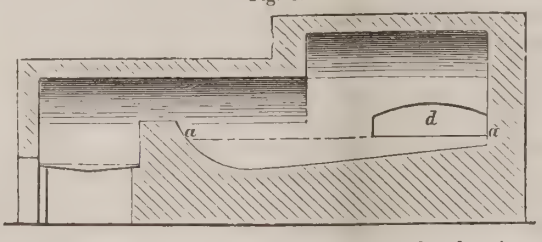


reservoir of cold water, and the supply of water is regulated by a stop-cock. Into the upper part of the core barrel is screwed the discharge pipe, *m m*, serving for the overflow of the heated water. There is besides another pipe which passes through the moulding box and the mould, and is even with the surface of the core. This pipe serves for the circulation of the water after the core has been withdrawn from the piece.

Before pouring, a current of cold water is passed through the core. While the mould is filling with iron two labourers continually stir the metal with long rods through the gait, to prevent the flaws (cold sets?) which were formed in the first attempts. At present these flaws are no longer formed; but this improvement must be rather attributed to the new form of reverberatory furnaces, which admit of giving the iron a higher temperature than before.

The construction of these reverberatory furnaces is given in plan and section in figs. 5 and 6, to a scale of 2 metres to ⅜ of an inch: *a a* is

Fig. 6.



the surface of the iron in fusion; *b*, the opening for charging; *c*, the discharging orifice; *d*, the communication between the furnace and the chimney; and *f*, the chimney, 80 feet high. The capacity of the furnace is such that 16 tons of iron can be melted at once.

When the mould is filled with iron and it is certain that there has been no loss or escape, the wood shavings on the grate, *b b*, are lighted and the fire is made in the pit by throwing on coal; at the same time there is passed into the core a current of water sufficiently strong to prevent the temperature of the water rising above 30° R. (= 99·5° Fahr.). The temperature of the overflow water is noted every hour, and when it is certain that the metal is completely solid, which is shown by the diminution of the temperature of the water, the necessary arrangements are made for withdrawing the core. It is first given a strong pull by a large crane; then the speed of the current of water is lessened, so that the overflow water is nearly at the boiling point. By this means the layer of loam which envelopes the core becomes rapidly heated and the cord is charred, which is shown by the gases which escape. As soon as these gases cease the current of water is accelerated afresh, the core barrel cools again, and soon afterwards it can be withdrawn. On the removal of the core a current of water is passed

Fig. 7.

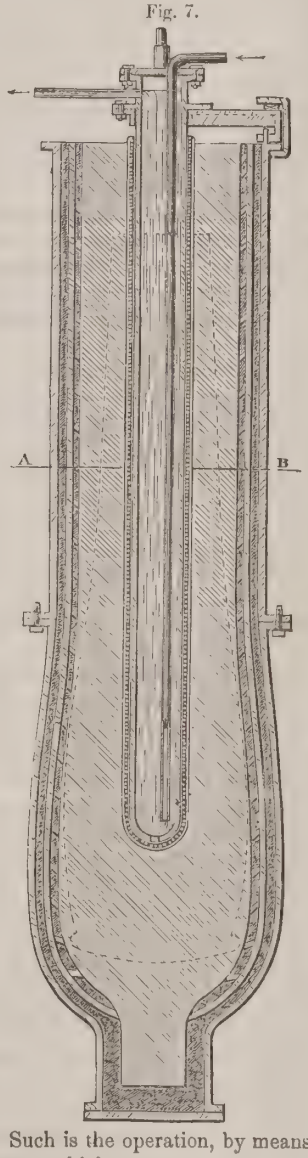


Fig. 8.

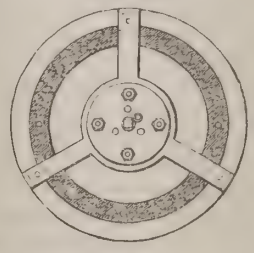


FIG. 9.

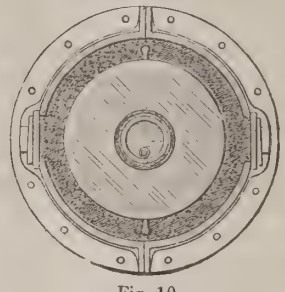


Fig. 10.

into the bore; this water overflows by the pipe, *n n*. The temperature of the overflow is still noted each hour, and as soon as it remains stationary it is a sign that the water carries off no more heat than the gun receives from the fire which surrounds it. The fire is then let out, and the current of water stopped.

Such is the operation, by means of which the outer layers have been given a higher temperature at the moment of solidification than the inner and already solid layers. The quantity of water which is thus passed through the bore of the gun is, in the case of the 8-inch Columbiads, fifty times the weight of the piece (150 cubic feet per hour for sixty-five hours). The increase of temperature of this water is on an average 2·7° R. (= 60·75° Fahr.); so that the water flows off at about 160° Fahr.

The boring of the gun is performed in three operations: the first merely cleans the bore by removing the loam adhering to it; the second removes the greater part of the excessive metal, only leaving a thin layer; the third completes the bore. The turning of the gun is done after the boring. Besides the numerous advantages already pointed out, this mode of manufacture requires less iron and less labour in boring than the old one. Many guns have already been cast by this process; among others a 15-inch gun, for the manufacture of which 34 tons of iron were melted in three furnaces. The finished piece weighed

22 tons; the charge was 35 to 50 lbs. of powder, and its spherical shell weighed 316 to 330 lbs. This gun has already withstood more than 100 rounds without the least injury.*

To test comparatively the old mode of casting solid and the new plan of casting with a core, several pairs of guns were cast, one of each pair by the old method and the other by the new. The results of the proof of these are given in the following table:—

Nature of Piece.	Mode of Cooling.	Class.	Time which elapsed from the Casting to the Proof.	Specimens.		Number of Rounds Fired.		Pieces which did not burst.
				Density.	Tenacity.	Service Charges.	Extra Charges.	
			Days.					
8-in. Columbiad, No. 1,	Exterior,	1	34	7·221	27,014	85	—	—
" " No. 2,	Interior,	1		7·226	27,962	251	—	—
" " No. 3,	Exterior,	0	30	7·288	37,984	75	—	—
" " No. 4,	Interior,	0		7 286	37,589	1500	—	1
10-in. " No. 5,	Exterior,	0	49	7·290	37,122	20	—	—
" " No. 6,	Interior,	0		7 294	38,513	248	—	—
32-pounder gun,	Exterior,	1	110	7·271	33,590	1000	6	—
" "	Interior,	0		7·281	34,308	1000	21	—

The two guns of each pair were cast at the same time and from the same iron; to this end the metal being melted in several furnaces was mixed in a common reservoir, whence it was conducted to the moulds by a forked channel.

As the table shows, all these guns differed very little in the properties of their component metal, yet the difference of resistance in firing was enormous, and constantly in favour of the guns which were cooled through the core. In the case of several of these guns the new process was not applied exactly as we have described. Thus the mould for the 10-inch Columbiad, No. 6, was not heated on the outside, but the pit in which the two moulds were placed was filled with sand well heaped up. And again, in the case of the 8-inch Columbiad, No. 2, the fire was lighted in the pit before pouring, so that the moulding box was heated to redness at the moment that the casting took place. This latter circumstance, which ought to have had an effect rather advantageous than the contrary, does not explain the small resistance of the piece; but it is to be remarked that the first two Columbiads were cast with grayer metal than the Greenwood iron which was used in the manufacture of the others. Whatever be the cause of the comparative weakness of the pieces, Nos. 2 and 6, the superiority of those cast with a core over those cast solid is incontestable, and it is especially remarkable in the case of the guns of Class 0.

Besides the greater resistance of guns cast with a core, these pieces also present the advantage of the metal forming the interior of the bore being much denser and harder, and consequently much less subject to degradation, as has been proved by a great number of observations.

* In the *Memorial de l'Artillerie Espagnole* for June, 1863, there is an interesting memoir by Lieutenant Guillermo Reinlein on the artillery of the United States. This memoir, which is later than that of Colonel Gadolin, contains, among other things, some new notes on the 15-inch Columbiads of the Rodman pattern, and on their manufacture in the foundry of Linapp, Ruddes, and Co., at Pittsburg. Fig. 7 is a vertical section to scale of $\frac{1}{48}$, representing the mould for a 15-inch columbiad after casting. After the detailed descriptions already given, this figure does not need explanation. We shall, however, point out the principal particulars in which it differs from the mould (fig. 2) preceding:—

1. The dry sand mould box is composed of two symmetrical half boxes, as in fig. 2, but each half box is again divided into two parts by a plane perpendicular to the axis; the lower part is considerably widened out to a bottle shape, the upper one is cylindrical.

2. The case, or body of the core barrel, is furnished with a cylindrical pivot with a square end. This pivot serves, conjointly with a similar pivot when screwed into the lower part of the barrel, to turn it round its axis when coating it with loam. The second pivot is afterwards removed and replaced by a screw plug stopper, which, we need scarcely remark, must be scrupulously water tight.

3. The two siphon gaits communicate with the interior of the mould by openings arranged at intervals of 3 decimetres = 11 81 inches—practically, 12 inches—apart for the whole height of the mould, which results in this, that the mould is filled by means of the siphon gaits in the upper as well as the lower part of the casting.

4. The thickness of dry sand forming the sides of the mould is everywhere the same, so that there is a great excess of metal at and towards the muzzle (the finished piece is figured in dotted lines).

Fig. 8 is a plan looking down upon the upper part of the mould, core barrel, &c., scale as in fig. 7, $\frac{1}{48}$. Fig. 9 is a transverse section of the core and core barrel, showing the longitudinal air channels formed on the external surface of the latter, to scale of $\frac{1}{10}$; and fig. 10 is a transverse section at A B in fig. 7, and to same scale.

According to M. Reinlein, a 15-inch Columbiad tried at Fortress Monroe has fired 1500 rounds, with charges varying from 30 to 60 lbs. of powder, and shells weighing from 315 to 335 lbs.

After obtaining this result at Pittsburg, it was decided to introduce the same process into the other foundries, and no longer to accept for the service any guns not cast hollow.

Independently of the experiments which we have just analyzed, and which have to do more directly either with the properties of the iron or the mode of casting, a great number of researches have latterly been made, which bear indirectly on the resistance of cast-iron guns.

Admiral Dahlgren, starting from the experiments made at Bomford on the pressure of the gases of the powder in the bore (according to method analogous to that which was afterwards employed by Colonel Neumann, of the Prussian artillery, but not nearly so perfect), designed some guns for the marine artillery which have always shown themselves to have great endurance. A very useful change has been made in the form of the Columbiads, of which we have spoken above; it consists in suppressing the breech ring and in rounding off the first reinforce with the button, by an arc of a circle.

Captain Rodman has designed an apparatus for measuring the pressures of the gases in the bore, which, he states, gives more accurate results than any others hitherto employed for the same purpose, and what is more important, is very easily used. By the help of this apparatus he has made some experiments on the influence of the size and form of the grains of the powder upon its rate of burning and on its detonating (*brisant*) effects, and he has proposed a size and form of grain which enormously diminishes the injurious action of rapidly burning powder on the gun. The results of these experiments may be found in the number for November, 1861, of the *Journal de l'Artillerie Russe.*

Captain Rodman has also made experiments on the maximum pressure of the powder gases at different distances from the bottom of the bore, and relying on these experiments, as well as on some special experiments, consisting of bursting some small cylinders of cast iron by hydrostatic pressure, he has determined the form as now given to the 15-inch Columbiad, a gun which up to the present time, it is said, leaves nothing to be desired in the opinion of the American officers of artillery.

We cannot dwell longer on these interesting and useful researches. Some of the results obtained in America have already been taken advantage of in Russia. The Rodman apparatus for measuring the pressure of the powder gases has already been used at the proving house at Wolkowa, and it has been satisfactorily ascertained, thanks to this apparatus, that the pressure of the gases in the Russian rifled 24-pounder gun, with the service charge and projectile, is not greater, but on the contrary, is less than the pressure which the old 24-pounder gun, with the spherical shot, was subjected to. When this same gun burst soon afterwards, it was accordingly deemed as certain that it could not have been caused by the excessive pressure of the gases, but was probably due to the too rapid rate of inclination of the driving surfaces of the spiral grooves, which caused the projectile to act through its wings or buttons, somewhat in the manner of a wedge.

The preceding remarks in somewhat sweeping praise of Captain (now Major) Rodman's apparatus for experimentally ascertaining the pressure of the powder gases, at successive points along the length of the chace, are not ours, but Colonel Gadolin's. Although readily admitting the weight justly attributable to his authority, we are by no means prepared to go the same length in admitting the sufficiency or the exactitude of Major Rodman's method or apparatus for the above purpose. That it is capable of giving, perhaps, tolerably reliable *comparative* results, within not very widely separated limits of pressure, is conceivable; but it seems to admit of greater doubt that the *actual* maximum pressure of the powder gases in the chace has ever been truly ascertained by it, or we may add, by any other direct apparatus yet contrived. The *direct* determination is beset with difficulties, and up to the present time *indirect* determinations deduced from experimental results as to *velocity* from point to point in the chace, as procured by the apparatus of Captain Schultz of the French artillery, appear capable of most nearly approximating to the truth. This, however, is not the place to enter more fully upon the question. As regards our final estimate of value of these American researches, apart from the Rodman method of gun moulding and casting, there can be but one opinion as to their having placed experimentally, in a clear and decisive position, several facts as to the iron-founding metallurgy of cast iron, all of which, however, had previously been known and described. Still there is a certain indecision of theoretic view, a want, indeed, of any guiding theory to colligate the facts and to reconcile those which appear apart or in conflict, which

greatly detracts from the value to the iron founder, generally, of these American researches.

In fact, there is much the same confused notion as to the why and wherefore that repeated fusion, or long continuance in fusion, &c., of the metal produced castings of increased strength, that prevailed in Mr. Fairbairn's paper on the former part of the subject. In the remarks which we have either interspersed or placed in foot-notes during the recital of these United States researches, we have endeavoured briefly to supply the theoretic clue necessary to lead the reader clearly through the labyrinth; and if the student of iron founding as a science as well as an art, will carry in mind in reading the last three or four articles of this series, "On Some Points of Practice in Iron Founding," what we have pretty fully elaborated in previous ones, as to the effects of repeated and of long continued fusion on cast iron, he will find that he will derive great light in considering the results here recorded by the American experimentalists.—ED.

THE PARIS EXHIBITION.

STEAM AND OTHER FIRE-ENGINES.

THE name of fire-engine is *legion* at the Exhibition. Besides our English manual engines of the type so familiar to all Londoners, there are hand fire-engines from almost every nationality in Europe, as well as from Canada and the United States. Some of these are very odd productions. A few with horizontal long-stroked cylinders, and outrageously long strokes at the handles, betray an imperfect conception of the fundamental principles of design in fire-engines, or, indeed, in any machine to be given reciprocating movement by the arms of men. Others, such as several from the German countries, as from Kurtz, of Stuttgard, Wirtemberg, and others, are extremely neatly made, and got up with a degree of finikin finery, suggestive of gingerbread in the constitution, and almost as repulsive to good taste as the flaunting and flaring scarlet and yellow of the typical London fire-engine.

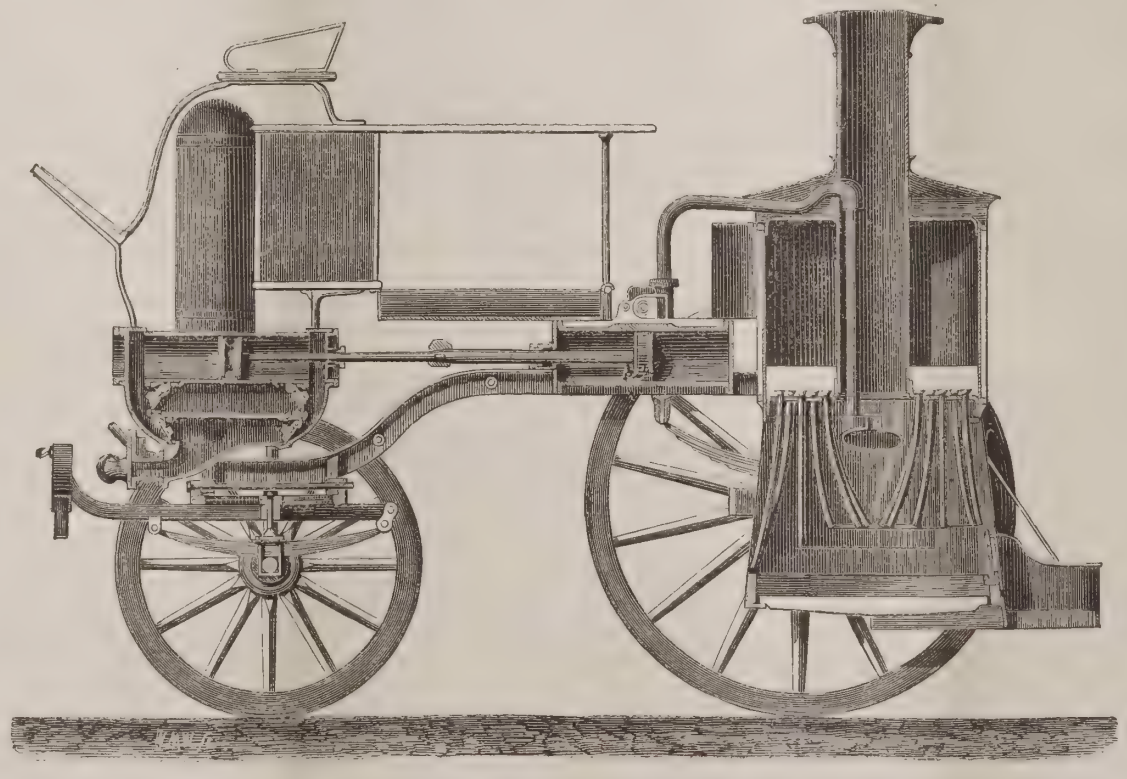
Austria produces a fire-engine of merit, with a wrought-iron plate cistern, and only wanting in iron wheels to be on a par at least with some of the best metallic fire-engines that have been made in Great Britain.

There are some very cheap-looking, but scarcely to be objected to, Belgian and Swiss hand-engines; and there is a tribe of "extincteurs" and fire annihilators, and other omnipotent salamandrine giants of that breed, whose powers are only exceeded by those with which they are paraded and puffed by those interested.

None of the manual engines have, we believe, been tried or tested against each other. Perhaps it would hardly repay the trouble, for any great knowledge to be gained; but where medals are concerned, and mercantile reputations are made to rest on such, we can but again and again repeat that these ought not in any case to be decreed without trials comparative previously had. However, manual fire-engines are in some small degree already passing off the stage; and hence trials of them are the less important, though we do not suppose that they can ever become really obsolete, for steam fire-engine giants are not needed everywhere; and it is quite certain that if we could only provide secure and systematic arrangements by which accidental fires should be discovered and early dealt with, the poorest old parish "squirting machine" would be more than a match for them; and the steam giant might, like Enceladus, remain for ever chained to its stone station floor.

It is not without significance of trust in our own "British manufactures," here at least justly bestowed, that we remark the British executive has taken right good care to have one of Shand & Mason's, and we believe another of Merryweather's, fire-engines laid up in the central garden, close by the British picture gallery, and between that and the fountain ponds in the said garden.

Steam fire-engines were not largely, nor very early, represented at



the Exhibition. However, examples by our two great British makers, Shand & Mason and Mr. Merryweather, and two of French make on American models, viz., one by Mons. A. Thirion, of Rue Vaugirard, Paris, with a vertical boiler and vertical cylinders upon a single pair of wheels, and with shafts for the horse; and another constructed at Havre, in the workshops of the Ocean Forges et Chantiers Company, on the model of Lee & Larned's American engine, have been produced, and three of them tried very completely, though neither rigidly nor scientifically.

In the trials made at the exhibition about two months ago, Merryweather's large engine, though very closely pressed by Shand & Mason's, did beyond question perform the best, and they have been adjudged a gold medal in Class 53, and the only one given to steam fire-engines.

The above longitudinal section makes the general arrangement of Merryweather's large engine tolerably clear.

The following remarks embody the views of these gentlemen themselves as to the chief merits of their engines, and we have willingly adopted, almost in their own words, the explanations they have addressed to us of the several points which they deem those of chief merit in their own construction. We have been able to do this in most

cases because they represent their own views temperately and fairly, and on the whole we are enabled to agree with them.

At the competitive trial at the Champ de Mars their large engine *L'Empereur* threw a massive stream 1¾ inch diameter to the extraordinary height of about 200 feet. The main features that seem to have made this system of engine successful in practice and in the various competitions that have taken place since the introduction of steam fire-engines into England, are the simple and powerful boiler and the large long stroke of the pumps which are employed, so that the rapid motion which is so detrimental to all pumping machinery is avoided. Another feature is the absence of any rotary motion to move the slide valves, thus saving weight and the multiplication of parts, as where cranks and eccentrics are used. The section above given shows the construction of the boiler on the "Field" patent, one which has been well tested in practice, not only in steam fire-engines, but in a variety of other and chiefly manufacturing purposes, over 200 being now in use. It has proved economical of fuel, in addition to its other good qualities. This boiler consists of a top plate, in which are hand holes, and a bottom plate in which the tubes are fixed. These tubes, unlike those in ordinary vertical tubular boilers, do not reach from the bottom to the top plate; but, having their lower ends welded up, hang down as it were from the tube plate over and around the fire. Within each of these tubes a pendant tube is placed open at both ends, the lower end not reaching to the bottom of the outer tube, and the top end fitted with a capped mouth, so as to assist in promoting the naturally rapid circulation of water which flows down the inner tube, and being conveyed to the bottom rises again with the steam up the annular space between the two tubes, and is deflected by the capped mouth, so as to be prevented from interfering with the downward current. This plan for rapid circulation gives out, practically, dry steam above the water level into the steam space, which for boilers of this class is made unusually large, being unencroached upon by tubes. Steam in these boilers is got up remarkably quickly. In one instance at a public trial a pressure of 60 lbs. per square inch was obtained in 6 minutes, and 100 lbs. in 7½ minutes from the time of lighting the fire, cold water only being used. The steam is also well maintained.

One of the advantages claimed by the makers for this system of boiler is, that it is comparatively very free from the liability to overheating; for there is no water casing in the ordinary sense of the word, there are no large surfaces exposed to the action of the fire, the tubes alone are exposed, thus very much protecting the tube plate. In case of prolonged want of water, one or other of the tubes at their most exposed end would no doubt give way first. The interior of the boiler is readily got at by unscrewing a nut of a hand hole on the top, by which the tubes, &c., can be reached. Those of the working parts are attached to the boiler, which is mounted on a strong wrought frame, and is attached to the steam cylinder only by the steam pipe. The frame is of angle steel or iron, stayed and supported by steel springs in front and rear, with strong axles, high wheels, and forelocking carriage to which the horses may be attached. By the arrangement of the steam cylinder next to the boiler over the hind wheels, and of the pump and its valve chambers over the fore carriage, the weight is pretty evenly distributed on the wheels. The pump and steam cylinder (or the two of each) are strongly coupled together, and are fixed horizontally on the framing. The advantages of horizontal instead of vertical cylinders in all steam fire-engines, we have pointed out in an article on the steam fire competition at the Crystal Palace, in this journal for September, 1863. The pumps and valve chambers are of gun metal in one casting, so as to avoid joints; the valves are placed below the pump cylinders, the delivery valves being at the lowest point; hence on ceasing to work all water leaves the pump dry, and so prevents accidents from frost in cold climates. The delivery outlets are furnished with stop-valves, which is a good and convenient arrangement. The feed-pump suction works out from the delivery of the main pump; its action is thus rendered more sure. A boiler feed is also taken from the main pump, and another from a Giffard's injector, for which there is a supply tank fixed at the front side of the boiler, so that the failure of water is pretty well guarded against. It is stated that observation of the working of Messrs. Merryweather's engines at the Paris Exhibition has procured them an order for a large engine for the town of Lyons.

There can be no question but that the trade in steam fire-engine making is likely to become a very large one. It is a specialty well worth the attention of the most intelligent of our mechanical engineers, and especially of the first-class makers of locomobiles. So far we think, and we say it devoid of any favour or prejudice to one party or another, these makers have kept in the van of their special manufacture. Much, however, yet remains to be done. The points needing attention on the part of all makers are to simplify and cheapen steam fire-engines, and to reduce their design to forms capable of ready fabrication by machine tools. Until steam fire-engines shall have thus been made with interchangeable parts, and upon a common type, they will not become everyday affairs and go all over the world as they ought. For ourselves we cannot but think that a far simpler and better steam fire-engine than any yet produced is practicable, by taking a wide departure from any existing type.

In a steam fire-engine, of all others, a rigid attention to economy of fuel is unimportant; the maximum of power in the minimum of weight, and the most direct and immediate connection possible between the steam power and the water, are the main points, to which good proportioning of parts, though highly important, is but subordinate.

If anywhere in the whole range of mechanics, the inherent and inevitable defects of the rotary form of steam engine appear fit to be overlooked in favour of the power they give of direct action upon the water, and almost without valve gear or such like connections, it is here. We believe that a disc steam engine, coupled directly on to a disc pump, might in fact be made the archetype for the design of a steam fire-engine greatly in advance of anything that has yet been produced.—Ed.

GAS-WASHING APPARATUS AT THE EDINBURGH AND LEITH GAS COMPANY'S WORKS, LEITH.

A new apparatus for washing gas and air has recently been set up at these works, having been devised by the company's engineer, Mr. John Reid. The following observations show the necessity for an improved appliance of this nature:—

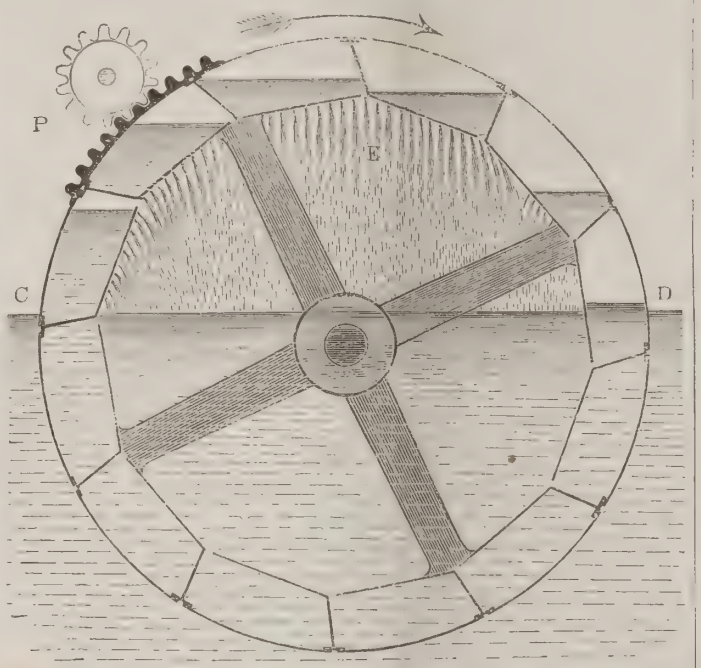
Various forms of apparatus have been devised for effecting the washing of impurities from air and gas, which must be effected upon the stream of gas as it passes rapidly onwards from the retorts, and with as little impediment to its free passage as possible. One form was long, and is still, continued in many gas-works, consisting of an oblong iron chest, about 25 feet long, by 6 feet wide. The top of the chest slanting off the level, one end being 7 or 8 inches lower than the other, an elevated chamber is constructed at each end as entrances and exits for the gas. The vessel is charged with such a body of water that the depressed end of the cover is submerged some 7 or 8 inches. The gas on being introduced within the chamber at the lower end, presses down the surface of the water sufficiently to make a passage for itself along and under the cover to the chamber at the exit end, and in doing so, is broken up into bubbles, which, in struggling their way through, become partially washed by contact with the water, which slowly becomes impregnated with ammonia, and is from time to time withdrawn and replaced with fresh water. An obvious objection to this form of washer, is the imperfect contact of the large globules of gas with the washing liquid, which ought, moreover, to be kept continually in an active state of agitation by some kind of stirring apparatus; but the greatest objection is the backward strain of pressure thrown on the retorts by the hydrostatic pressure exerted by the gas in forcing its way through the machine.

Numerous contrivances have been adopted for getting rid of this objection, and that now in general use consists of an iron structure, of 25 or 30 feet high, of a circular or rectangular shape, and from 3 to 6 or 7 feet wide. The gas being introduced into the bottom of the vertical vessel, passes upwards to the top, where it escapes by an outlet pipe, or, as the case may be, enters a second column, and descending passes out at the bottom. Powerful pumping apparatus is employed to force up to the top of the structure a constant stream of water, which, falling in a shower through the passing current of gas, generally effects the washing process satisfactorily. The same water is pumped over and over again, until it has been so impregnated with ammonia that it is removed, and fresh water again introduced. This form of machine is not free of serious objections. The first of which is the difficulty of pumping up a sufficient volume of water to meet the greatly increased volume of gas that is passing the machine in winter, as compared with summer, which usually amounts to three or four times the quantity in the same time; and it is also a matter of well-known experience, that

all kinds of pumping machinery requiring, as in a gas-work, to act day and night without intermission are very liable to get out of order, and unless relays of apparatus are kept in readiness against accident, it is obvious that no stoppage for repairs can take place, without allowing the gas in the meantime to pass without the washing process. It is estimated that every 1000 feet of gas should be treated with 100 gallons of water (the water, of course, should never be below four or five degrees of saturation, otherwise it has a deteriorating effect on the illuminating power). The constant elevation of this body of water to the top of such a machine is expensive in engine power, and from the liability to get out of order for this work, it is a constant subject of care and anxiety in every large gas-work during the whole of the winter months.

The leading idea of the improved washer is to substitute a *horizontal* instead of a *vertical* passage for the gas while being submitted to the action of the shower of water, whereby it should undergo a thorough

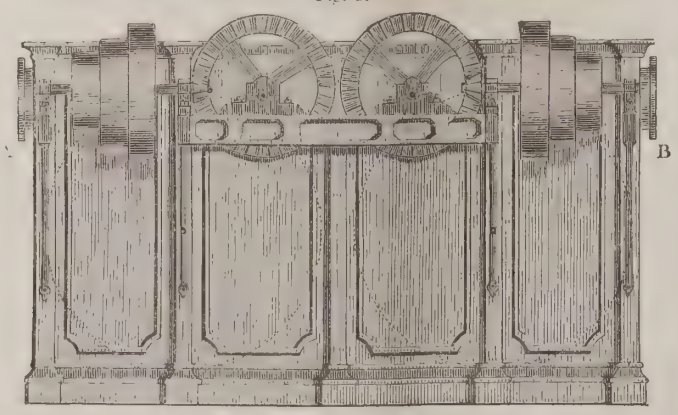
Fig. 1.



shower-bath from a copious stream of water jets, falling some 20 inches, in an elongated horizontal chamber, instead of 30 feet in height; and that this should be effected without in any way presenting obstruction to its free passage, or throwing any back pressure on the retorts.

The apparatus consists of a cast-iron close cistern, ornamented externally by panelling: its dimensions being about 14 feet long, 12 feet wide, and 6 feet deep, having a longitudinal vertical partition dividing

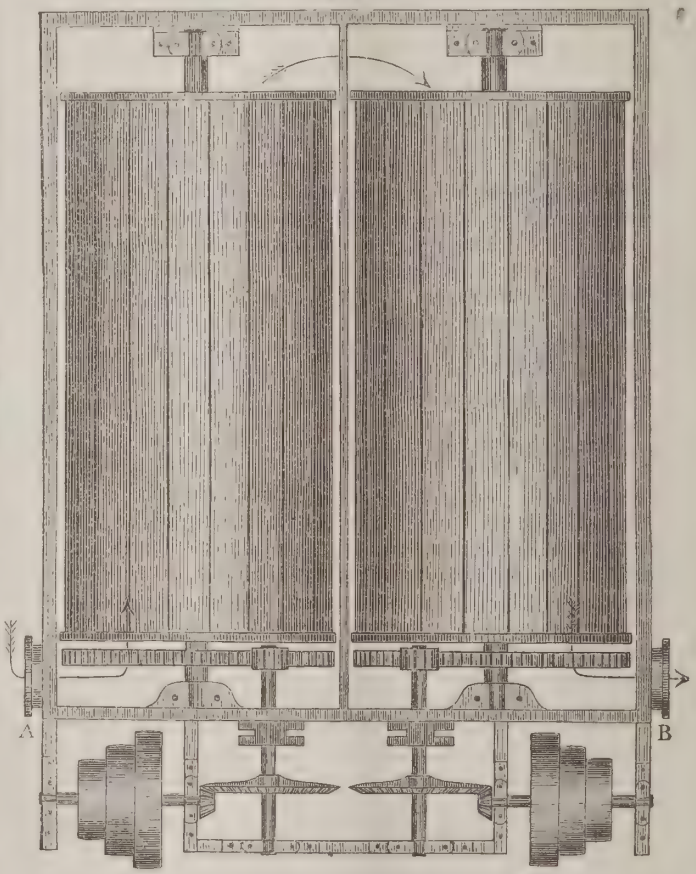
Fig. 2.



its interior into two equal-sized chambers, 14 feet long, 6 feet wide, and 6 feet deep. In each chamber is fitted a revolving hollow cylinder, some 10 feet long, and 5 feet external diameter, with strong malleable-iron axles, and lignum-vitæ bearings fitted inside the principal chest. The periphery of each cylinder is built all round with cast-iron buckets, twelve in number, in the manner of a water-wheel, with this difference, that with the exception of air-slits in the outside of each bucket, they are close all round the circumference. The interior surface of the buckets, about 10 inches less in diameter, is closed in with thin cast-iron plates, perforated with holes an inch apart, and one-quarter inch diameter. Each cylinder is mounted at the front end with a spur-wheel, actuated by pinions within the chest, for giving to each a slow rotatory motion, at about one and a half revolutions per minute. The pinion shafts pass by a stuffing-box to the outside, and are mounted with wheel gearing and driving pulleys, which are driven by engine power.

The chests being charged with water to the height of a few inches above the centre of the axles, and the cylinders being set in motion in

Fig. 3.



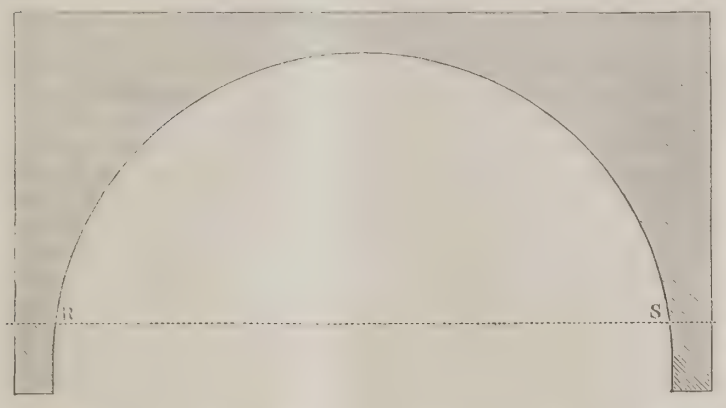
the direction of the arrow, fig. 1, which represents an end section of the cylinders, each bucket emerging from the water line, C D, discharges a copious shower of water through the internal perforated plates, into the interior vacant space of each cylinder, and each bucket thus discharging its contents is nearly emptied by the time it reaches the surface of the water on the opposite side, as shown on fig. 1. Fig. 2 is a front elevation of the machine on a smaller scale than fig. 1, showing the outer driving gearing, and the inlet and outlet passages for the gas, A B. Fig. 3 is a plan of the machine; the entrance for the gas being at A, and exit at B. Fig. 4 is a cast-iron plate or screen, closely fitting the sides and top of the chest, and with a semicircular cavity accurately fitting the periphery of the front end of each cylinder, which is turned truly for this purpose; the two lower points of this plate, dipping a few inches into the water, compels the stream of gas entering at A to pass only through the *interior* of each revolving cylinder. On discharging at the back end of the first cylinder, a suitable aperture allows the gas to cross through the middle partition of the chest, and enter the interior of the second cylinder, and after passing forward through its interior it escapes by the outlet at B.

The volume of water thus brought up from the lower depths of the vessel amounts to 225 gallons per revolution for each cylinder, being 450 gallons for the two, and the speed making 1½ revolutions per minute. There are 675 gallons, or three tons, of water per minute

showered by this apparatus upon the gas passing through it in that period of time.

To provide this copious shower in the ordinary washer would require appliances of a formidable character, in the way of pumps and other tackle. Here nothing of this kind is required; while the motive power

Fig. 4.



requisite to lift the water about 18 or 20 inches in this machine is less than *one-twelfth* of that required to lift the water 30 feet in the old form of washer.

When the water is changed, it is only done partially, and the ammoniacal saturation is never allowed to fall lower than 4° to 5° in strength, and it is usually worked up to 10° or 12° before it is run off; and in this condition it is sent to the chemical manufacturer for the production of sulphate of ammonia, its relative value being measured by its strength. The highest strength of this liquor attainable with advantage by the old washing apparatus rarely exceeds 5° or 6°.

Coincidently with the washing process, a small stream of condensing oils, if made to flow into the chamber, and being thus agitated along with the water, imparts to the gas additional illuminating power.

While no gas can possibly pass through this machine without being thoroughly scoured with water, it is of no less importance that care be taken to prevent this process being overdone, lest the light-giving properties of the gas are weakened. It is, therefore, very necessary that the amount of water brought into contact with the gas should be regulated in proportion to the volume requiring to be acted upon. This can be done perfectly. By reverting to fig. 1 it will be seen that, while the space, E, for the passage of the gas under the shower, is well proportioned for, say, 50,000 feet per hour, all that is necessary for adapting it to a lesser volume is to raise the level of water, and by thus contracting the opening, the passage of the gas is proportionally quickened in its current through the machine; and as each cylinder is furnished with separate driving apparatus, one can at any time be thrown off, and the remaining cylinder left to do the work.

The small amount of steam power requisite for giving action to the apparatus is a matter of importance. It may further be stated that while in ordinary machines the small jet holes used for spreading the water are very liable to be choked up by tarry matters constantly flowing through them in one direction, there is no such tendency in this one, owing to the circumstance that the holes are discharging the liquid in one direction while above the level of the water in the vessel, and as soon as submerged they are filled by the flow entering in the opposite direction, and this back and forward action during each revolution keeps the holes perfectly clear. The buckets of each cylinder are furnished with ventilating slits in the outer covers, for facilitating the filling and discharging of each bucket with gas and with water, alternately, as the cylinder moves round. On account of the rapid destruction of brass from chemical action inside, the journal bushes of lignum-vitæ show that it is excellently adapted for the work; an examination, after eighteen months' work, showed that this wood had undergone no sensible wear, and it neither requires nor receives lubrication while working under water.

Having thus shown how effectively this form of apparatus brings large volumes of gas and water into intimate contact, it readily suggests itself as a suitable apparatus applicable to the removal of particles of dust or soot, and otherwise for the purification of common air, in conjunction with hot-air stoves, which are now so extensively in use for heating and ventilating large public buildings in our large towns. The removal of mechanical impurities by passing the air through a spray of water, was effected long ago by Dr. D. B. Reid in the original ventilating apparatus for the houses of Parliament, and the water once thus applied thereafter ran to waste. But the mere removal of dust is only of partial benefit, as impurities of a more subtle and dangerous character are often poured into large buildings over the heads of congregated crowds without being suspected, and are no doubt productive of serious evils to health. It need only be stated that, as a rule, the supplies of air for heating hospitals, churches, theatres, and other large buildings, are drawn in from near the level of the ground, and in too many cases from the stagnant atmosphere of some back court, where, in addition to its ill-conditioned state, it not unfrequently gets farther polluted by gaseous emanations from cesspools and adjacent sewer gratings. But although care be taken to avoid these palpable errors in the planning of ventilating apparatus, it is quite impossible in densely populated towns and ill-ventilated localities to procure pure air for this purpose. Yet it may be practicable, with a washing apparatus of the kind under notice, to purify it before being passed into a large building. The washing liquid could be charged with disinfecting agents, to render any impurity at least harmless.

The machine we have described has been constantly at work now for about two years, and we learn that in every respect it has given much satisfaction, not having during the whole of that period been stopped for repairs or any other casualty. Mr. Reid recently brought it before the Royal Scottish Society of Arts, and the committee who were appointed to examine into it have reported highly in its favour.—V. D.

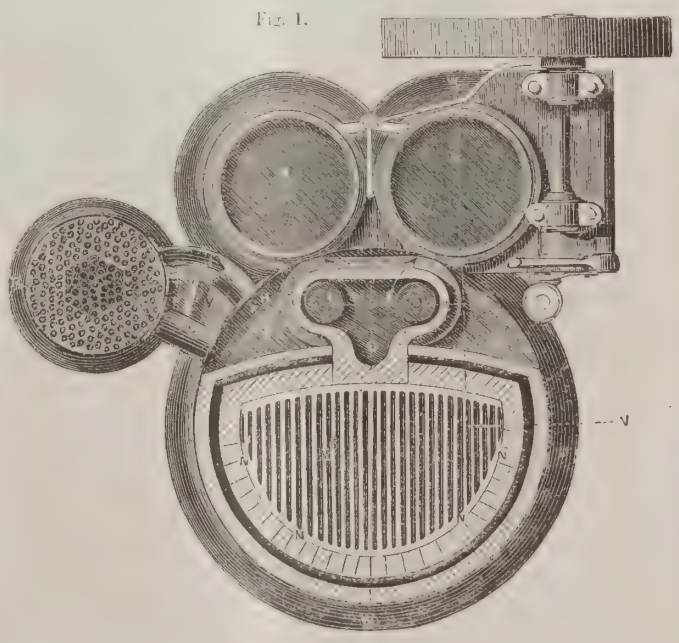
PARIS EXHIBITION.

NOTICES OF SOME SPECIALLY INTERESTING OBJECTS, &c.

SHAW'S HOT-AIR ENGINE.

In an open shed in the neighbourhood of the British boilers at the Champ de Mars there was a small but somewhat noisy engine that attracted a good deal of attention. This is the hot-air engine of Mr. Philander Shaw, of Boston, U.S., and it is probably the most successful attempt that has yet been made to employ hot air as a motive power. It occupies a space of about 8 feet square, is of the indicated power of twenty horses, and it was employed for the purposes of the Exhibition in turning a screw in a tank of water. The inventor states that his engine

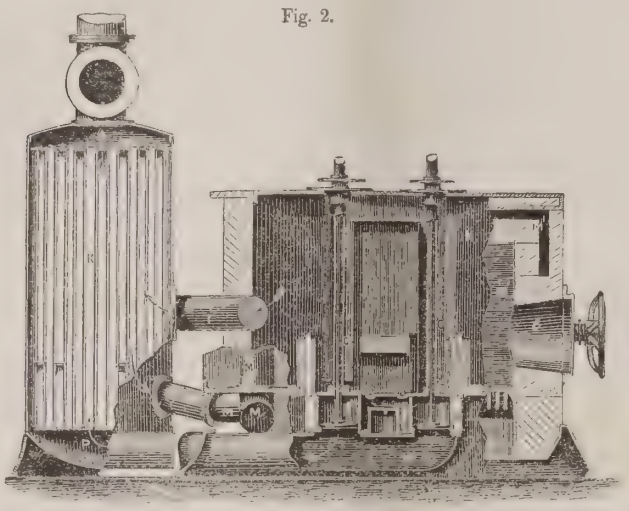
Fig. 1.



requires very little attention compared with a steam-engine, and that its consumption of fuel per horse-power per hour is less than that of the best class of steam-engines. Instead of heating the air in a receiver, it is heated in the furnace itself; there is therefore much less loss of heat.

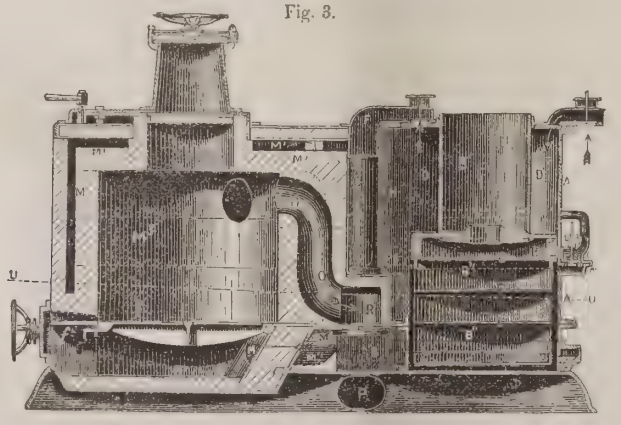
and the engine is got to work much sooner. The accompanying cuts will show our readers the construction of the engine. Fig. 1 is a sectional plan through U U, in fig. 3. Fig. 2 is a longitudinal section through V V, in fig. 1; and fig. 3 is a section through W W, in fig. 1. A is one of the cylinders; B, the piston; B′, the piston trunk; B″, the piston extension; C C C, diaphragm plates; D, annular space surrounding B′, which serves for the air pump; E, inlet valve for cold air; F, discharge valve for same; G, pipe leading into the hot-air valve; H, cold-air chamber; I, pipe from same to the auxiliary heater; K, auxiliary heater; L, pipe leading from the auxiliary heater to M; M, pipe conducting cold air into the ash pit and air chamber, M′, surrounding the

Fig. 2.



combustion chamber, M^3; M″, damper controlling the passage of air into the furnace; N N N, small apertures through which the air enters the combustion chamber; O, pipe conducting heated air from the combustion chamber to the cylinder; P, exhaust pipe conducting expanded air from the cylinder, A, into the tubes of the auxiliary heater; R, induction valve for hot air; S, eduction valve for same; *a*, fuel receiver for supplying the fire while the engine is in motion; *b*, circulating passage admitting cold air round the valve seats; *c*, valve admitting cold air in the chamber, *c′*, surrounding the piston; *d*, vacuum valve; *e*,

Fig. 3.



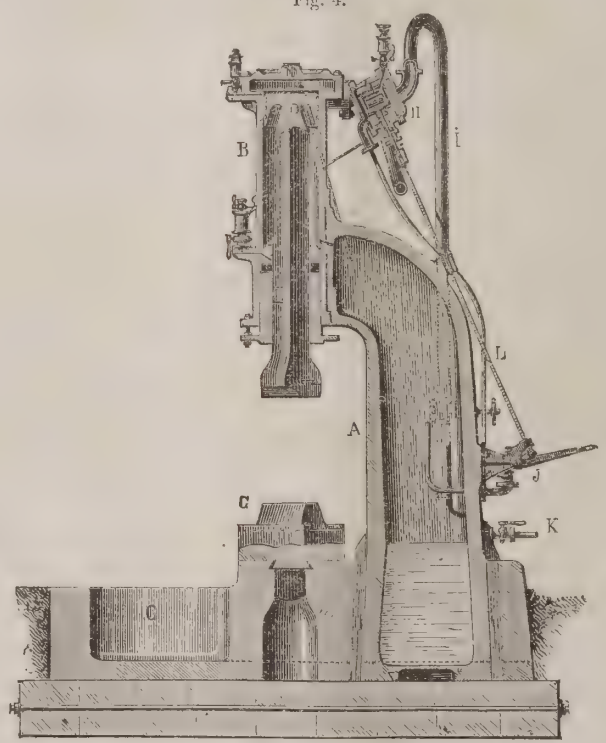
furnace door; *f*, ash door. The single-headed arrows in fig. 1 indicate the course of the air to the furnace, and the double-headed arrows indicate its course on leaving the furnace.

The action of the engine is as follows:—After the fire has been kindled and the engine sufficiently heated to expand the air, the doors are all closed air tight, and in a few seconds the expansion of the products of combustion and the heating of the air inclosed in the furnace will give the pressure required to start the engine by merely turning the crank over the dead centre. Suppose the piston, B, to commence its downward stroke, the pressure from without will open the valve, E, filling the air pump, D, with cold air; the return stroke of the piston, B, forces this supply of air through the valve, F, and the pipe, G, into the hot-air valve, R, and cold chamber, H; from thence it passes by the pipe, I, to the auxiliary heater, K, into the space surrounding the tubes, where it receives the heat imparted to the tubes by the exhaust air. From the auxiliary heater the air passes through the pipes, L and M, the latter of which opens at one end into the ash pit and at the other into the air space, M′, surrounding the combustion chamber, M^3, where it receives the final heating, and is then admitted by the hot-air passage, O, and hot-air valve, R, to the cylinder, A, and after actuating the piston is discharged by the exhaust valve, S, and the exhaust passage, P, through the tubes of the auxiliary heater out of the chimney.

FARCOT'S STEAM HAMMER.

Messrs. Farcot & Sons exhibit a steam hammer, which differs in principle from other apparatus of the same description in that the fall of the hammer is effected under the influence of the active steam, instead of being determined by the weight of the hammer itself in conjunction with the pressure of a cushion of steam or compressed air disposed at the top part of the cylinder. In this hammer the ascent is produced by the cushion of steam, which for this purpose is placed at the lower part of the cylinder. In the type which we illustrate by the annexed figure, the double standard is replaced by a single support, A, which admits of free access being obtained to the anvil, G. The piston, E, of the cylinder, B, is rectangular in section, which facilitates the guiding of the same in a vertical direction; its lower end is provided with a steel sabot, which forms the hammer proper. The top part of the cylinder carries a cast-iron hood or cover, the interior of which, being larger in diameter than the piston, D, is bored to receive a thin plate, which is perfectly free to move, and performs the functions of a piston, and above which the steam is introduced to form a cushion to receive the shock of the hammer at the top part of the cylinder. The tube, I,

Fig. 4.



conducts the steam to the slide-box, H, from whence it is conveyed into the hood of the cylinder and into the reservoir, A, in the interior of which it is maintained without outlet. The steam contained in this reservoir constitutes the cushion which effects the upward motion of the hammer, and it is maintained at a constant pressure by means of a valve which admits of the introduction of fresh steam when the pressure diminishes in the reservoir. The volume of water proceeding from the condensed steam may be augmented by adding water from other sources with a view to modify the capacity of the reservoir, and to adjust its proportion relatively to the degree of compression that the steam undergoes at the time of the descent of the hammer. A cock, R, is provided for this purpose at the top part of the standard. The hammer is put in operation by a motion of the hand-lever, J. The steam, which is introduced above the piston, D, acts on the hammer, which descends,

compressing the steam in the reservoir, A, which should be maintained at a pressure lower than that of the boiler. The slide being then released, it immediately returns by the action of the springs placed on the rod, L; and the steam above the piston escaping, the piston re-ascends by the pressure of the steam in the reservoir, which becomes expanded so as to balance the weight of the hammer. The number of blows of the hammer thus depends upon the rapidity with which the lever, J, is actuated; and the extent of the fall is also determined by the action of the lever, since the hammer ceases to rise immediately the steam is introduced above the piston, D. The weight of the blow given may also be regulated by cutting off the steam before the end of the stroke.

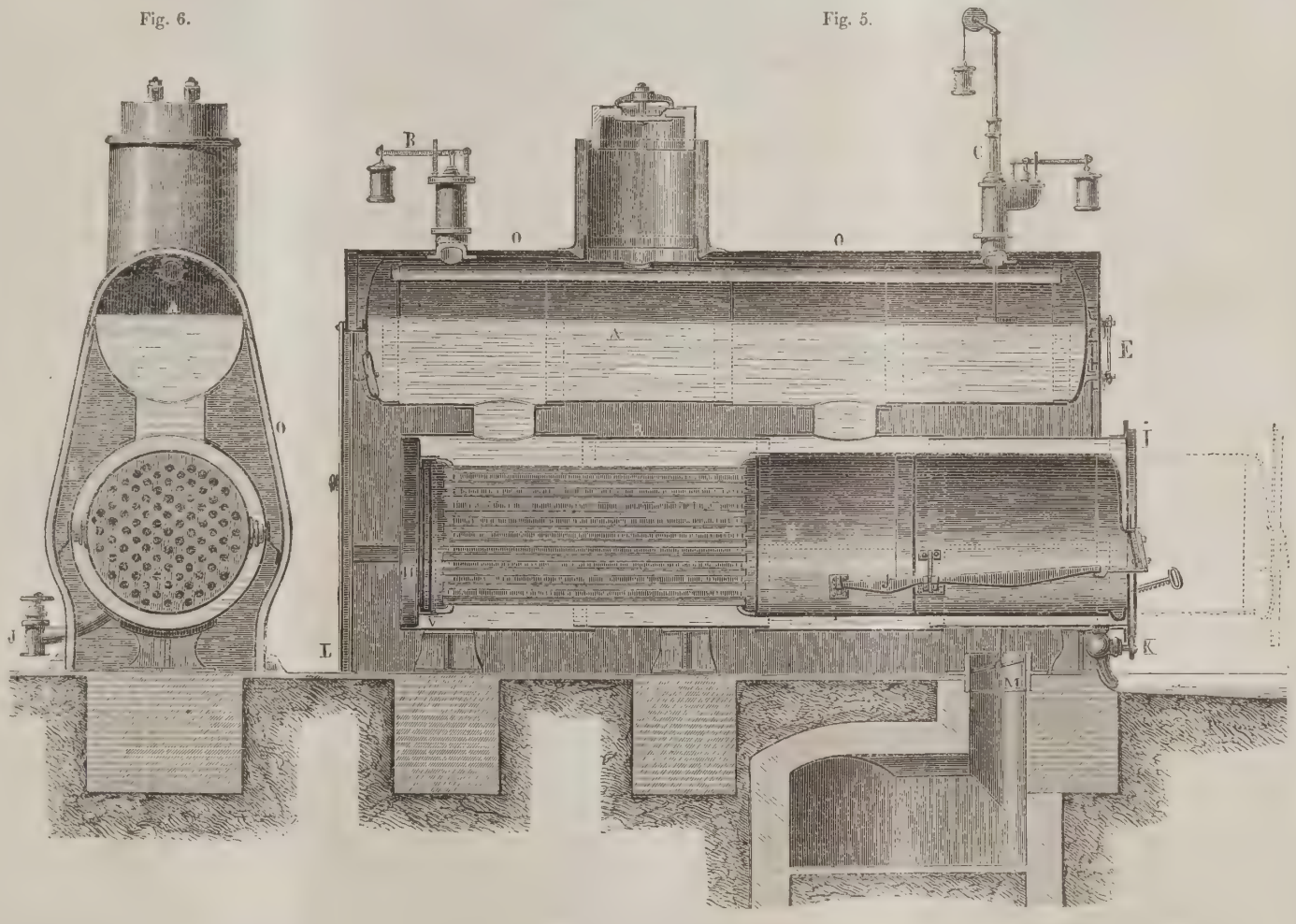
FARCOT'S BOILER.

Figs. 1 and 2 are respectively transverse and longitudinal sections of a boiler exhibited by Messrs. Farcot & Sons, which is a combination of the tubular and the ordinary cylindrical type. It is composed of two cylindrical bodies, the upper one of which, A, serves as a water chamber and steam chest, and is provided with a species of steam dome, into which the steam is introduced through a longitudinal slot, F, formed in the top part of the steam pipe. The object of this arrangement is to prevent the water being carried away with the steam. The other body of the boiler is composed of the casing, R, which forms a lower water reservoir, the furnace, X, and the tubes. A small supplementary fire grate, J, is provided for use when it is required to temporarily augment the production of steam.

The whole of the boiler is surrounded by a casing, O, for the retention of heat; this casing is formed of plate iron, inside which is a layer of plastic material. The casing may, however, if desired, be replaced by brickwork. The internal parts of the cylindrical body, R, consisting of the furnace and tubes, are rendered movable by securing the cylinder R, by means of metallic points, H and I, which may be easily taken down, so as to facilitate the cleaning of the tubes. The tubular system and the furnace connected together are supported by rollers on T-iron

Fig. 6.

Fig. 5.



attached to the body of the boiler. In order to effect the cleaning of the interior of the boiler it is requisite first to disconnect the joints, H and I; the tubular system is then drawn along until the tubes project from the body of the boiler, the front of the fire-box being protected by an accessary roller, and the incrustation on the boiler may then be removed without difficulty. A special tool, somewhat resembling a fine saw blade, is used for the purpose; it is inserted in the spaces between the tubes, and so disposed as to describe a curvilinear hexagon around each of them, which are thus perfectly scraped and cleaned without its being necessary for the operator to see them.

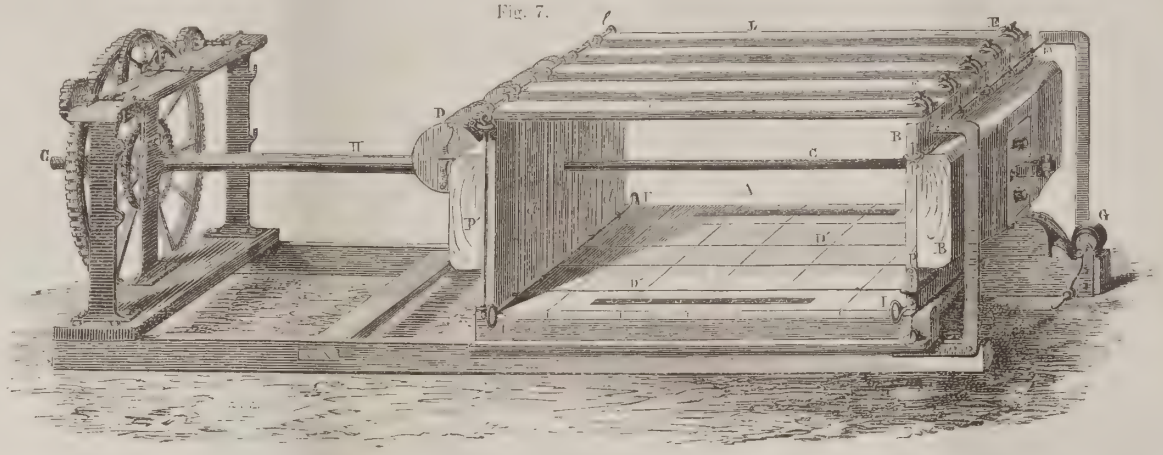
MESSRS. TIQUET & PERGAUD'S FORAGE PRESS.

The annexed cut illustrates a forage press for the compression of hay, straw, &c, exhibited by Messrs. Tiquet & Pergaud, ironmasters of Magny in France. This press is composed of a case, A, the face of which, B, is movable, and actuated by the rod, C, which is connected with it at will by a pin, and the fore part of which has a screw thread formed on it which enters the cast-iron socket, H, forming the shaft of the large spur wheel. The plate, B, is provided at its lower part with rollers which run on the frame. With a view to increase the strength of the rod, C, a steel pin is passed through it at the place where the screw thread commences, the ends of which pin enter helicoidal grooves formed in the socket, H. The rod is capable of withstanding a thrust of at least 60,000 kilogrammes. The compression of the forage is effected by means of the spur wheel, which is successively actuated by three pinions of different diameter, so as to impart to the socket, and through it to the screw and the plate, B, a motion retarded in proportion to the advanced state of compression of the fodder in the case.

In order to commence the operation, the cover of openwork planks, L, is removed; the end of the screw, C, should then be situate at about the middle of the case, A. Then after adjusting in the grooves, *d* D′, the four bands (of cord or iron wire) from the bobbins, D, securing them by the rods, T, and attaching them to the back rod, F, by passing them along the guides, E, the forage is inserted up to about one-half the

height of the case and transversely to the screw; the screw is then passed into the plate, B, and secured by a pin, the case completely filled, and the cover replaced. The case is closed on one side by a door for which hinges, P, fixed to the plate, B, and a rod, P′, attached to the other plate, are provided; and when loose straw or hay is to be operated upon, both sides are closed. When the apparatus is thus in working order, the operation of pressing is commenced and performed with a diminishing velocity by means of the three different-sized pinions, as

Fig. 7.



before explained. The compression being completed, the bundle or truss of forage is tied up with cords, furnished by the bobbins, D; the cover is removed and the key passed into the rear end of the screw; the plate may then be conveyed back to its place by the aid of the wheel, G, and the truss withdrawn from the case.

Two men are sufficient to work the machine; but if three are employed, 3000 kilogrammes of hay or straw may be operated upon per diem, its density as it proceeds from the case being about from 175 to 200 kilogrammes per cubic metre.

MESSRS. RANSOMES & SIMS' EXHIBITS.

Messrs. Ransomes & Sims, of Ipswich and London, make a very fine general display of agricultural machinery. In the centre of their stand they show ploughs adapted to all countries of the globe; and although many of them are much improved since the Exhibition of London in 1862, they exhibit the greatest novelty in the shape of ploughs in the whole building. It consists of a new turnwrest plough; the breasts are fitted to the side, and when the right-hand one is at work the other one is lifted out of the ground by means of a rack and pinion attached to a handle close by the ploughman. When he arrives at the end of a furrow he turns the plough round in the usual way, and by turning his handle again he causes the left-hand breast to commence work whilst the right-hand breast is lifted out of the furrow. These ploughs are specially adapted for ploughing hilly lands, and also for ploughing on the flat where reaping machines are used for cutting the crops.

The next machine we noticed was the new portable engine fitted with expansion valves, a double pump, and heater for pumping the water in a boiling state into the boiler. These engines are designed for those countries where coal is not indigenous, and where usually the water is bad. The boilers are constructed so that there is ample room round the fire-boxes and around the tubes, and it can be kept clean and in order although the worst water may be used. The fire-box is also very deep, and has a large heating surface, enabling these engines to burn bad wood, cotton waste, maize stalks—in fact, any sort of fuel. The axles are enormously strong, and the whole of the engine is designed for use in those countries where great difficulties have to be overcome, and skilled labour of all sorts is scarce.

The self-moving engine is also an excellent specimen of this type of engine. The boiler is constructed so as to burn wood or coal; the cylinder is placed at the back of the chimney, and the motion of the engine is communicated to the driving-wheels by means of spur gearing, which is very strong, and will not easily break. The engine is fitted with two speeds, one at 2½ and the other at 5 miles an hour, and the driver, by a very simple arrangement, can alter the speed from 5 to 2½ miles an hour, which enables him to take the same load up a steep incline as he would on an ordinary level road. All the handles for reversing the engine, putting on the break, turning the steam on, &c., are arranged very neatly around the stoke-hole, and enable the driver to regulate his engine without leaving the foot-plate. The steersman is placed immediately behind the driver, and steers the engine by means of a powerful wheel connected with the front axle by a chain and strong iron rods. This arrangement is preferable to the one in which the driver is placed in front of the engine, as, when behind the driver, he is always enabled to communicate with him at any moment, and to see the train at the back of the engine.

On the other side of the stand is the new threshing machine, invented by Messrs. Ransomes & Sims, for use in hot countries. This machine is constructed in the same manner as their ordinary threshing machine, but is provided with an apparatus for chopping and bruising the straw. The apparatus consists of two rollers revolving at a great speed, one of which cuts the straw to the proper length, and the other bruises and macerates it. Until this machine was invented it was found impossible to introduce steam threshing machines into hot countries, where no hay is grown, and where the cattle are fed entirely upon softened straw, which has been prepared for them up to the present time by the old system of threshing, in which a number of horses were galloped round in a circular space into which a large quantity of corn had been placed; the continuous motion of the horses' hoofs threshed out the corn, and left the straw in a broken and softened state. These machines are used chiefly in Spain, Turkey, Egypt, &c.

On the upper part of the stand we noticed a pair of very beautifully-finished corn-mills, which are adapted chiefly for those countries where the portable engines are used either for pumping or for threshing, or for other operations which do not continue throughout the whole year. These mills are generally placed in villages, and worked direct from the portable engines by means of a strap, and they will produce the finest flour. Messrs. Ransomes & Sims have also two engines in the Exhibition building, one of 10 and the other of 14 horse-power; the latter, which is fitted with expansion valves and heating apparatus, has attracted great attention on account of its beautiful proportions and the excellence of its workmanship.

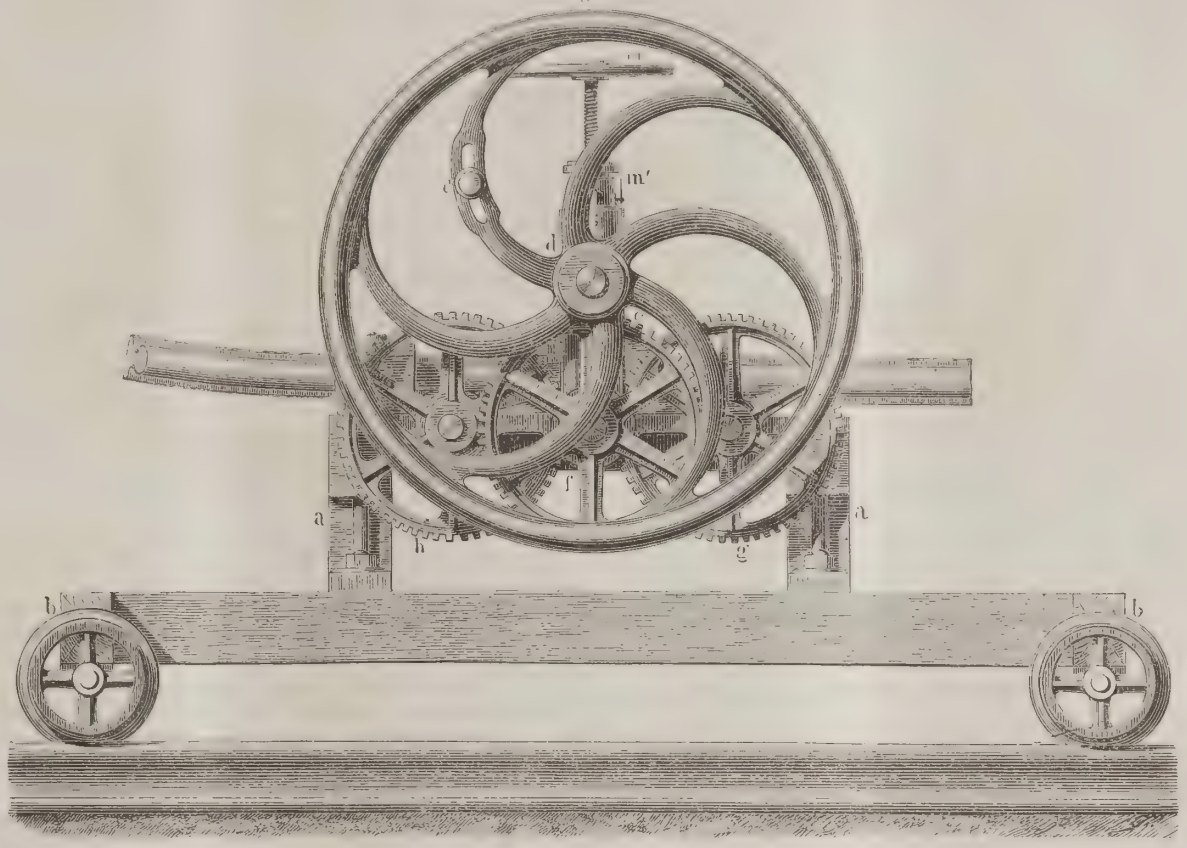
This firm has also a 14 horse-power engine in the marine annexe, alongside the Pont de Jéna, which drives Messrs. Penn's large marine trunk engines built for H.M.S. *Sappho*.

MILLET & ROGÉ'S RAIL-BENDING MACHINE.

Messrs. Millet & Rogé exhibit a machine, the invention of Mr. Rogé, for bending rail and other iron flatwise and perpendicularly ("sur champ et sur plat") at the same time, which is shown in side elevation and end view by figs. 8 and 9, respectively. The machine is composed of a cast-iron frame, *a*, carrying six cylinders, three of which are disposed horizontally and three vertically; the former of which being designed for bending horizontally, and the latter in an upright position, each series forms an isosceles triangle. The two lower horizontal cylinders, *j*, turn always at the same height, and the axis of the upper one, *k*, is supported in a movable cap, *l*, which renders it capable of vertical motion. This motion is produced by means of a screw, *m*, actuated by a wheel; and a hand, or pointer, is provided at the upper part of the frame of the machine to indicate the amount of revolution performed

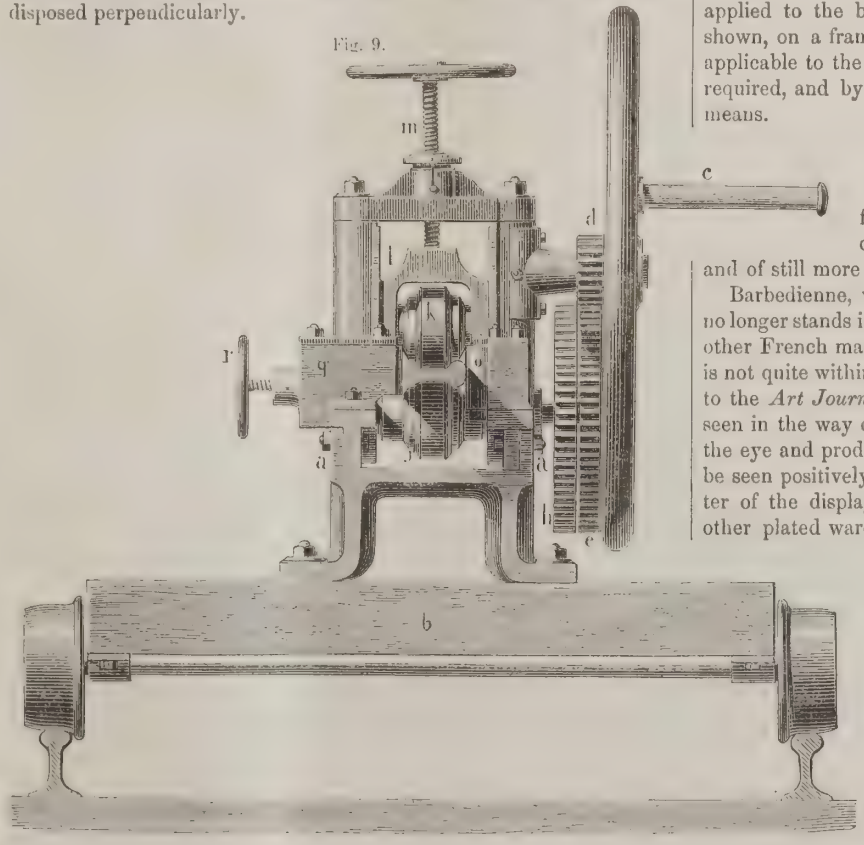
by the wheel, and consequently the distance traversed by the movable cylinder, *k*, each division on the graduated scale corresponding to a certain depth of descent of the cylinder. The greatest accuracy is thus obtained when bending horizontally, and by a similar arrangement

Fig. 8.



of the vertical cylinders the same effect is produced in bending the iron disposed perpendicularly.

Fig. 9.



The machine is generally worked by hand by means of a handle, *c*, attached to the fly-wheel, and the intermedium of gearing, *d*, *e*, *f*, *g*, *h*, which impart rotatory motion to the lower cylinders, *j*, the cylinder, *k*, turning by friction. In our illustration the machine is represented as applied to the bending of rails, for which purpose it is mounted, as shown, on a frame or carriage, *b*, which runs on the line; but it is also applicable to the bending of other irons than rails in which curvature is required, and by it greater accuracy is obtained than by the ordinary means.

BRONZES.

These, as works of art, are displayed in amazing profusion by France, whence this supply to the luxury of the opulent has become a great branch of European, and of still more distant export trade.

Barbedienne, who was *facile princeps* in 1862 in this department, no longer stands in such unchallenged supremacy; the displays of several other French manufacturers at least worthily rival all he can show. It is not quite within our scope to particularize much here. That belongs to the *Art Journal* mainly. There is good, bad, and indifferent, to be seen in the way of design. Some things in the over-struggle to catch the eye and produce to the vulgar, at least, the notion of novelty, are to be seen positively detestable as objects of art. But the general character of the display of bronzes, like that of plate and of electrotype or other plated ware, and of porcelain, proves France in art manufactures to be still far in advance of ourselves.

It may be very doubtful whether any amount of culture in art—even were the nature of such culture at all understood in Great Britain, or the apparatus adequate and suited to its promotion and diffusion, which it is not—could evolve out of the genius of British men and women anything like the same amount (we do not say the same sort, for that is not possible between any two distinct peoples) of feeling and love for art that exists in France, and that inspires the glorious displays of art manufacture they present. Climate has far more to do with these things than surface-skimmers of knowledge are able to realize to themselves; so have religion and its ceremonies, forms of government, the relations of armies to the body politic, social conditions, moral codes

and notions—all go to make, or to prevent the making, of the artist, or the art workman.

At present, however, the art manufactures of France appear to us perfectly unapproachable by ourselves; and however true it may be, and no doubt is, that very large improvement in our commonplace, everyday art manufactures, such as in furniture, crockery, carpets, hangings, and the like, has undoubtedly taken place since 1851 and the epoch of *Punch's* British blue dinner plate; still in all the higher range of art manufactures there appears to us, after a careful examination, to be just as great a gulf of disparity between ourselves and our French rivals *now*, as there was in 1851. We have improved; that is, we have become more or less clumsy and often most senseless and unreasoning imitators, of much in the way of art manufacture, which most of our British tradesmen and their workpeople only became aware of the existence of, and saw for the first time in their lives in 1851. But it is simple nonsense, contradicted by nearly all that an eye educated up to the point to be able to judge, observes now in the Paris Exhibition, to affirm that South Kensington, with all its loud talk and well paraded apparatus, has had any real deep or soul-stirringly influence upon the art manufactures of these countries in their higher departments. The fault is not all at Brompton, however much at fault "the department" may be. The proverb says, we cannot make a silk purse of a sow's ear, and the truth of it is clear enough to those who have art poetry enough in them, rightly to appraise the brazen images that those who rule in "Science and Art" in England have within the last twelve months set up in the streets of London, and by that alone.

THE PRODUCTION OF OXYGEN GAS AND OF CHLORINE BY MR. A. MALLET.

The production by any economical process of oxygen gas in abundant volume at will, would undoubtedly result before very long in many surprising and important extensions of our power in the applications of heat and light, and most probably, as in nearly every like case, in the evolution in abundance of various bodies previously not obtainable, at least by the manufacturer, and in the establishment of quite new branches of industry. It would be as it has been with the history of aluminium, but in the case of oxygen upon a much more fructiferous scale. There is nearly one-third of the whole catalogue of metals, for example, about which next to nothing is known as to the capabilities of the metals themselves for ministering to the wants of man. Who knows anything worth mentioning of the manufacturable properties of tungsten, manganese, titanium, strontium, &c.?

Several considerable improvements have from time to time been made in the old time-honoured process of procuring oxygen for the laboratory, &c., by heating oxide of manganese; but up to a late period nothing that was capable of giving a steady evolution in such volumes as to admit of becoming a manufacture under certain and economical conditions. One process, however, that of Mr. A. Mallet, does now seem to present those conditions, and was exhibited in operation on a pretty large scale at the Exhibition at Paris in a building upon the Quay of the Seine, below the Pont de Jena. This process is founded on the property of protochloride of copper, Cu_2Cl, to absorb the oxygen of the air, and become transformed into oxychloride, CuCl, CuO, and the capability of that when heated to 400° to restore this oxygen and pass back to the state of protochloride, and so on. This process gives the means of obtaining quite sufficiently pure oxygen almost without the expenditure of any material; for loss by manipulation is avoided in the apparatus intended for the manufacture on an industrial scale. In fact, the material is inclosed in horizontal retorts, to which is given a rotary motion, and it never leaves them, the distillation and revivification taking place in the same vessel. Some inert substance, such as sand or kaolin, is mixed with the coppery material for the purpose of avoiding fusion. The rotation of the retorts is to equalize the temperature, and to mix the material both in the distillation and the subsequent revivification by a current of air. The requisite temperature is comparatively low, and is not greater than that required for the decomposition of chlorate of potash. On a small scale the operation can be performed in glass. The revivification is rapid, if the material be a little moistened, and there be a suitable current of air. Three or four hours is enough with the rotation of the retorts, which allows of incessant contact of the material with the air. The loss, as has been said, is next to nothing. An experiment on a small scale, in which the material was taken out of the retort after every distillation to be revivified, in 100 grammes, only suffered a total loss of 9 grammes in twelve operations, and produced 36·760 litres, which is equal to a loss of 1 kilogramme per 4 cubic metres, and at 1·20 franc the kilogramme, the cost would be 0·30 franc the cubic metre. But in the above described method, the loss, as has been said, is nothing, and 1 kilogramme of material gives 28 to 30 litres of gas.

A great advantage in this process for preparing oxygen consists in the ease with which it can be changed into one for the production of chlorine, with the same apparatus and the same material, by adding hydrochloric acid to the latter, after its revivification by the air. This transforms it into bichloride, CuCl. On the great scale the gaseous acid coming from soda furnaces would be used, so as to avoid the water of the commercial acid. The preparation of chlorine by the decomposition of bichloride of copper had already been pointed out by M. Laurens, professor of chemistry at Rouen; but difficulties in the manipulation and in the apparatus had prevented the commercial success of his plan.

The furnace arrangements, as exhibited at Paris, were very simple and easily managed, though not admitting of intelligible explanation without drawings, which as yet we have not been able to obtain. Nor are we in a position to state with any precision and certainty the cost per cubic unit of the oxygen obtained. We are informed, however, that the cost is so far below what has hitherto been the minor limit in cost of oxygen, that the chief commercial difficulty of the lime light for general purposes need no longer exist.

Another process for the industrial manufacture of oxygen, of ozone, and of oxygenated water, by M. Tessie du Motay, has been described. The inventor causes to pass over a mixture of equal equivalents of alkaline base and peroxide of manganese, put in a retort and brought to a red heat, a current of atmospheric air, which transforms the mixture into an alkaline manganate. The manganate is then decomposed by a current of vapour of water of 450° temperature, and the disengaged oxygen is collected. The operation is repeated indefinitely. Chromate and bichromates may be employed in place of manganates. According to the author, the oxygen would cost 47 centimes the cubic metre. The ozone is employed for bleaching, and the difficulty is to get it in the nascent state. The process of M. du Motay has been described in *Cosmos* for July last (1867), and that of M. Mallet in a communication made by Mons. Dumas to the Academy des Sciences, which will be found in the *Comptes Rendus* for 4th February also of this year.—Ed.

THE SMITHFIELD CLUB CATTLE SHOW, 1867.

MACHINERY AND IMPLEMENTS.

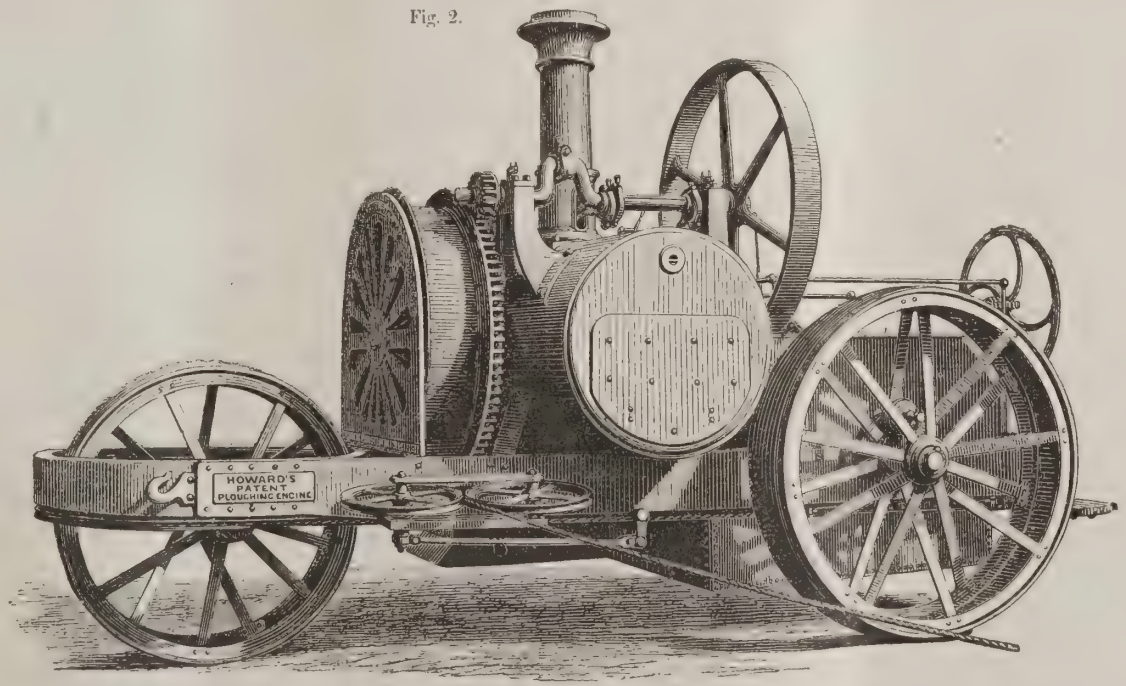
Two things struck us directly on entering this year the Islington Agricultural Hall—in itself decidedly the handsomest iron-roofed area in London:—First, the beautiful effect of the great level circles of gas jets, which, suspended along and over the vast central area, now illuminate the whole interior; and how suggestive these illuminants ought to prove to our Strodes, and other great gasfitters. Nothing can be more charming than the effect of the long line of luminous *coronas*, receding along the long length, hung in middle air, and each ellipse, from the nearest to the most remote, narrower and narrower, and becoming a mere line at the remoter end, and always changing by a beautifully determinate law, due to the equidistance of the spaces. Next, that the large and imposing display of machinery and implements made this year owes a good deal of its goodness, as well as its fullness, to Billancourt: the homeward-bound "exhibits" there, got up like other Paris beauties, "regardless of expense," have looked in at Islington on the way to new owners, or to whence they came. Were we to go into very much of descriptive detail we should, in a prolix way, only convey to our readers what we may say at once, and briefly. It is not possible that year after year, with so many brains busy, so many pockets hazarded, upon the production of agricultural machinery, there could be very much of novelty to be discovered or described every year, though *no* year is to be found without some one or more distinctive marks, in general and in particular. The former are, after all, by far the more important to note; and to one capable of taking a large view of these grand and most thoroughly and peculiarly English displays, and practical enough to note qualities of work and choices of adaptations and uses of materials, and the other many things that go

to make up the good, better, and best of machinery and implements, and can hold them, as seen from year to year, in remembrance—to any such one we say, the most noteworthy general fact shown by this year's display is the *vast* and *universal* advancement that has been made within the last three to five years in the design and as to details, and in the quality of workmanship and of materials, in every sort of agricultural machinery, but more especially in agricultural steam engines, locomobile, traction, fixed, or whatsoever other, and in all the heavier machinery to be driven by them. Five years ago the locomobiles that appeared at Islington were many of them obviously designed by men

Fig. 1.

whose eyes had never been trained by seeing first-class engine work, who had but scanty mechanical knowledge, and but a small armoury of "expedients" in the arsenals of design in their heads. The workmanship was also often but so-so, and gaudy paint and putty, and glittering varnish, helped off defects to the vulgar eye, but only made them more glaring to that of the genuine mechanic. We may now say, without one word of qualification, that all that is changed. Many of the locomobiles, the steam-ploughing and other engines shown this year, are as well designed and proportioned in their working parts, and as well and truly executed, and as delicately finished, as they could have been if

Fig. 2.

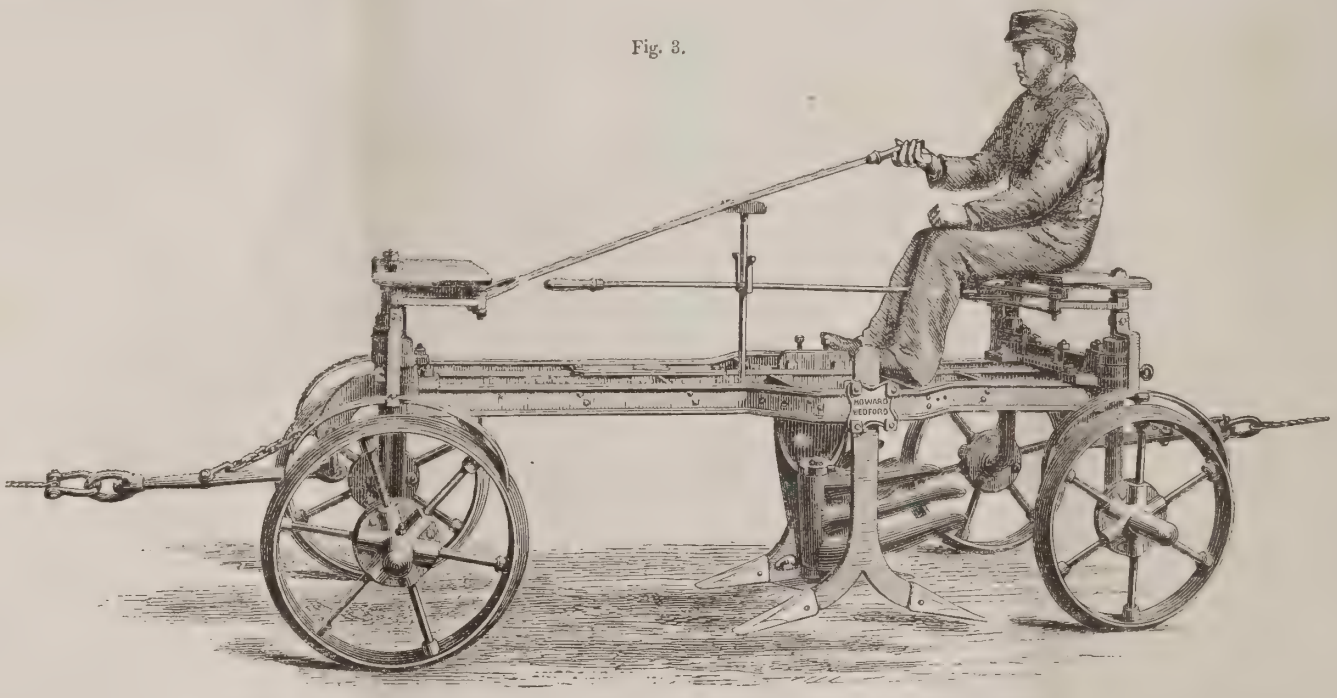


they had come out of any of the best locomotive engine shops in Great Britain.

There is also very plainly seen a wide-spread reign of *thought*, as ruling over the productions of establishments of our great agricultural mechanicians, a thorough realization of the aim in view, and a skill and heartiness in the adaptations by which it is very generally reached, that prove how universally intellect is possessed, and how ardently knowledge is applied, by this great class of our mechanical engineers—men so largely peculiar to this England of ours. Generalizations, when broader than their bases, are, like other top-heavy things, often dangerous; but comparing the progress of agricultural engine and machine making in England for the last five years with that of engine and

machine making in any other department—land, mining, metallurgic, or even marine engine making—we are disposed to say that the agricultural mechanicians have outstripped all their fellows in relative improvement within the epoch. No doubt there was more "sea-room," more scope for original inventive ingenuity in the solution of several grand problems, and such as these other walks of engineering did not present; but, with all allowances, there is really more *mind* and special technical knowledge shown in agricultural engineering in England at this moment than in any other equal range of mechanical engineering; and did all our walks of industry present the same results there would be some basis of reality and good sense for those journalists who, either through shortsighted ignorance or selfish and base personal motives, have for a time pretended to affirm that there is no need of technical education to be found amongst us. Can it be that *country air* has something to

Fig. 3.



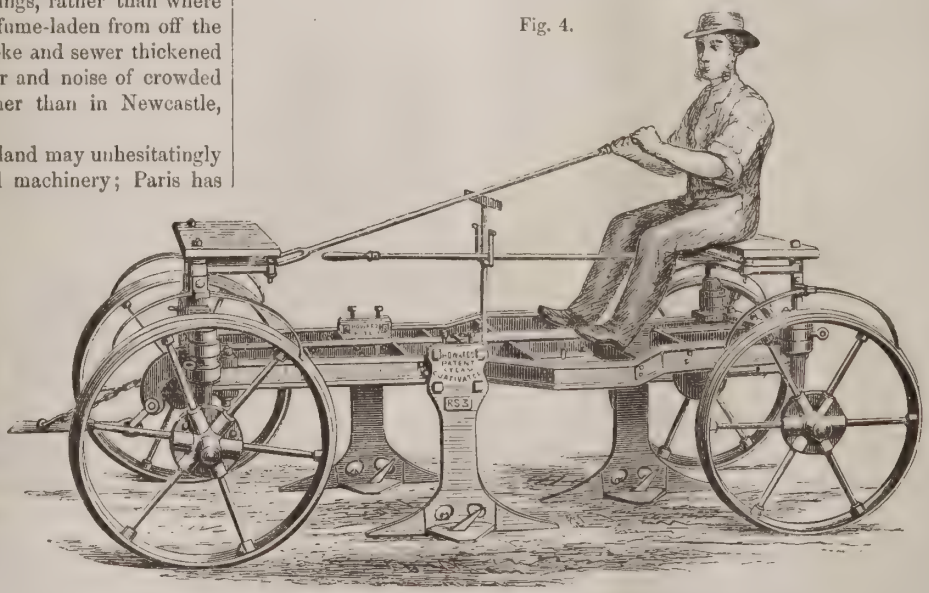
do with this agile step forward of our agricultural engineers? Clod-hopping has been generally deemed the synonym of stupidity and vacancy of mind, and these agricultural mechanics are not only by vocation "of the earth earthy," but nearly all their great establishments are located in agricultural districts, where the fustian encounters the smock-frock the moment it emerges from "the factory door."

We do believe that good air, both physical and moral, *has* something to do with it, for it needs little proof that, given the same mechanic's brains and limbs, these will yield results better both in quality and quantity, if worked in regions where the lark sings, rather than where the mouse cheeps; in the breath of spring, perfume-laden from off the rich brown fresh-turned fallow, than in the smoke and sewer thickened air that steams up amidst the flare and squalor and noise of crowded cities—in Bedford, Reading, or Ipswich, rather than in Newcastle, Manchester, or Glasgow.

However it may be, here are the facts. England may unhesitatingly challenge the world to match her agricultural machinery; Paris has this summer shown her that she would wisely be modest in such pretensions as regards a vast array of other branches of mechanical products. In truth there is, notwithstanding the propinquity of the butcher, an irrepressible poetry about these Christmas agricultural gatherings, characteristic in their every line of England, so impossible to be produced with the same setting or associations or on the same grand scale anywhere else. From the splendid horned cattle that lie about at rest or stand with quiet eye, patient to be caressed or felt, down to the unhappy porkers, whose grotesque load of living fat provokes a smile, up to the fair and healthy cheeked maids and matrons that one at once recognizes from the "city dames" as having come up from their "latticed bowers," to share in and witness the triumphs of fathers, husbands, and brothers, all tells of our English country life, in many of its aspects so beautiful, the most so of any rural life in the world, though in some respects too, alas! how much needing alteration, as to him who does the labourer's part in it, and as to his children.

He must be a dull fellow indeed, who can stand beside Howard's or Fowler's gigantic steam ploughs, or Howard's reapers and mowers, and whose thoughts do not fly off to the great plains of the far West, to the mighty river basins and deltas of South America, to Australia, and to many another land; nor feel that here are the potent tools that shall make these fertile deserts more than bloom like the rose, for these shall compel them to yield up their hidden store of food inexhaustible, for the alleviation of man's estate, in ever-increasing abundance to a posterity yet

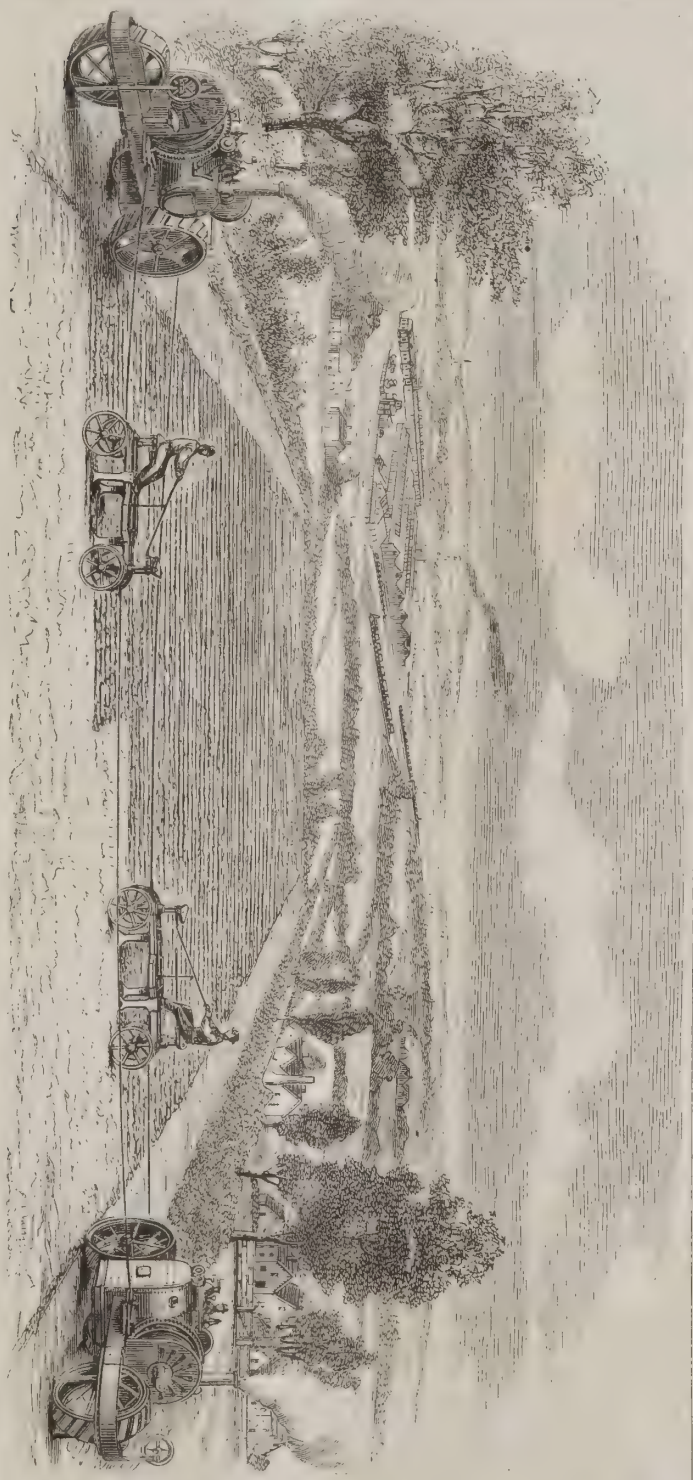
Fig. 4.



unborn. "In the sweat of thy brow shalt thou eat bread" can never be repealed by any art or skill; but the steam plough and scythe and sickle may, or rather must, multiply the bread that shall reward each drop that shall fall from the toiling brow of our race to come, to an extent

that to us now, if fully known, might seem like the miraculous multiplication of the loaves of old.

But we must kick off the buskin and walk over sober and present realities. The most notable objects we discerned this year were certainly Messrs. James & Frederick Howard's machine reapers and mowers. The same machine can perform both functions, but for reaping the mower receives the addition of an inclined receiving plane for



the shocks of corn, and of a four-armed rake to remove these in succession from the back end of the plane and deposit them in orderly form for the binders. The movements of these rakes are produced and regulated by certain very peculiar and ingenious forms of universal joints, and of two circular cams acting vertically; and their action is perfect. In fact, these huge rakes simulate the sentient movements of the hand of some unseen giant, in a way at once curious and to the mechanic satisfying.

Messrs. Howard's new arrangements of steam-ploughing machinery shown are highly meritorious, and the quality of their work of the high character that need not now-a-days be dilated on.

There are nearly 200 exhibitors of materials, machinery, or implements catalogued, and we might, did space allow, go nearly through the list with remarks descriptive or commendatory of the objects exhibited by nearly all of these. If we omit far the greater part, it is that we are compelled to select, and must leave much deserving without notice.

Messrs. John Fowler & Co., of Leeds, also show in the front rank as steam-plough engineers. There is nothing like perseverance for perfecting any mechanical problem, however difficult. When nine or ten years ago, Fowler was one of the pioneers of steam ploughing, probably he himself would scarcely have anticipated his present full measure of success, nor deemed it possible to turn over five acres per hour in regular work—to complete within the compass of an autumn or a springtide day the deep and perfect ploughing of a *sixty-acre* field. Yet this is what he is now prepared to sell machinery to perform.

Amongst the producers of power are Marshall & Sons, Gainsborough, whose improved vertical portable engines and boilers combined, have many points of excellence as well as first-class workmanship: their grist mills are very firm, substantial, tidy jobs. Aveling & Porter, of Rochester, sent their patent tramway engine, road locomotive, and locomobiles; Garrett & Sons, Leiston Works, Suffolk, corn, seed, and manure drill and broad-cast distributors, and their corn-dressing machines; Robey & Co., Lincoln, locomobiles and many other machines, including their steam elevators. Allen's double-expansion engine—not *the Allen Engine*, but that with the cylinder practically with two pistons working in it—has been taken up, and is being manufactured by Messrs. Garrett & Sons, as above. J. L. Norton, Belle Sauvage Yard, London, exhibits the American patent tube well, by which a limited supply of water, if the aqueous bed exist at a moderately small depth below the surface, can be obtained in a few hours, by driving into the ground a pointed and perforated (at the lower end) tube of iron of about 2 inches diameter. There can be no doubt but that this simple contrivance will find numerous and valuable applications in nearly every country. Brown & May, Devizes, exhibit some very neatly finished and light locomobiles, though not deficient in strength. Underhill, of Newport, Salop, shows his traction or locomobile engine, with driving wheels which have zigzag tyres, in our judgment an arrangement of a somewhat doubtful nature. Barrows & Carmichael have a portable steam-ploughing engine of excellent workmanship. Brown & May, a small locomobile, with water heater, arranged with some ingenuity, by the help of the discharged steam. Howard's patent safety boiler is shown in skeleton: it will be remembered that this was one of the boilers which supplied steam to the British machinery at Paris. Some little difficulty was there at first experienced in keeping the water level in this boiler aright, owing to the vast steam-generating power of the boiler itself, and to the circumstances of its connection with the steam mains of the other British boilers on other and older designs. This was overcome, however, and the cause being now fully understood, removes all objections of that nature to these certainly safe, and unquestionably powerful and economical boilers. Holmes & Son, of Norwich, Ransomes & Sims, Ipswich, the Beverley Iron and Waggon Company, Turner, of Ipswich, the Reading Iron Works, Edington, of Chelmsford, and several others, in addition to those we have previously referred to, are exhibitors of steam power in various forms, and much other well designed and finished machinery. Edwards & Co., London, show at work one form of hot-air engine, which worked steadily and well. For farmers in any country of the world where water is to be had, and we take it not much farming is to be done without it, we recommend the steam engine before any form of caloric or hot-air engine. The Hugon gas engine is shown at work: gas engines in the main are machines for city, not for rural use; for the former their value and many applicabilities will be increasingly appreciated. We are quite unable to follow with notices the implements and farm materials shown.

The oat and bean bruisers of the Reading Iron Works are of rare excellence and cheapness, as are the carts, &c., of Woods and Cocksedge, and of Cronkill, and the chaff cutters with iron framing of Ashley and Jeffery, of Stamford. Amongst things belonging indirectly to the farming establishment, Shand & Mason show a very excellent one-horse fire engine, the cylinders of which are about 4¾ inches diameter, and about 7 inches stroke, judging by the eye. There are the usual mowing

machines for grass plots, as well as the patent American "Clipper" mower, for grass crops as well as lawn. John G. Rollins produces quite an arsenal of American dodges, from hydraulic rams—whose duty seems but small—to hay forks and patent vices, and down to "lightning apple parers" and egg whisks. Amongst the carriages, Ayshford's village phaeton stands remarkable, as an extremely elegant and comfortable light little vehicle, for a cob or pony, and at a very moderate price. We omitted to notice, in its proper place, the adjustable corn screens of Barrows & Carmichael, of Banbury, constructed upon a very simple and ingenious device for adjusting the spaces between the wires at any instant, or stopping them altogether if desired. These screens are excellent in workmanship.

Amongst the odd things, half in, half out of place here, was the A B C gas meter (by the London and Westminster Meter Company), which not only registers and shows on its dials the volume of gas consumed, but its value in pounds, shillings, and pence. Clayton's brick and tile machinery entered its appearance as usual; but the greatest merits, after they have become well established, like the beauty that shows too often in public, must submit to be passed as matters of course. Millburns' dried grains, as a cattle food, is to us a novelty, how far a valuable one time must show.

The six prize cups, for cattle sheep and pigs, are very creditable in design and execution to Mr. Thomas, of Bond Street.

About one hundred gentlemen and members of the Smithfield Club sat down to the annual dinner at the Salisbury Hotel, Fleet Street, and with it ends our regards to the club, and its noble display, until, as we trust, its still finer one on the returning Christmas of 1868.—Ed.

WESTON'S PATENT DIFFERENTIAL RATCHET BRACE.

(*Illustrated by Plate* 14.)

The improved ratchet braces represented in the first three figures of the engravings are designed for the same kinds of work and to meet the same wants as the braces now in general use, simply affording in addition greater freedom and certainty of action with far more strength and durability. The ratchet braces illustrated by the remaining figures of the Plate comprise four new varieties of the tool, combining like advantages, with adaptability for use in situations where the ordinary brace is inapplicable, though much needed.

The series of braces, figs. 1, 2, and 3, have the same general structure, some details being shown more plainly on figs. 8 and 9. Fig. 1 is an engineer's *ratchet lever* for actuating lifting jacks, boring bars, &c.; also forming a ratchet spanner or nut wrench; fig. 2, the *dumpy brace*, with short feed screw; fig. 3, *drilling brace* for general purposes, with long feed screw. An explanation of fig. 2 will serve also for figs. 1 and 3, the same letters referring to corresponding parts. A is a coarse-toothed ratchet wheel forged solid with the usual feed screw, and locked firmly to another ratchet wheel, B, by the screws, C C, which lie half in one wheel and half in the other. The ratchets, A, B, embrace between them the eye or large end of the lever, D. E, E are steel washers interposed between the ends of the ratchet teeth and the lever, to prevent wear. One ratchet wheel is placed a half tooth in advance of the other, so that the palls, F F, act alternately, affording the requisite frequency of stops or engagements, with very strong deeply cut teeth, against which the peculiarly formed palls, F F, abut solidly without any "backlash" or danger of slipping. The ratchet teeth of ordinary braces are made small to obtain the requisite number of stops. Being small they cannot be deeply cut; they are therefore "undercut," which further weakens them and causes "backlash." The inner angle of the tooth is usually made very acute to retain the end of the pall in its place when at work; and on comparison with fig. 9 the difference will become apparent. Corresponding advantages in the durability of the springs and palls are obtained in the forms given to them and shown in the figures. F F are the palls, containing within them a curved spring, G, seen plainly in figs. 8 and 9, the length and curvature of the spring protecting it from breakage.

Fig. 4 is the '*angle*' *brace*, the head or ratchet part being of small diameter, to work within half an inch of the inner angle in angle iron, and in any similar confined situation. In this brace the two differential palls act alternately upon the same ratchet wheel, and are hidden from view within the box, H.

Fig. 5. *The Locomotive Brace.*—The very flat thin form of this brace permits its use in a very limited axial space. The short feed screw may be removed, as shown in fig. 11, when this brace may be used as a ratchet lever or spanner, or a feed screw of any desired length may be employed with it. The obtuse angle which is given to the teeth in the annular ratchet wheel, shown distinctly in fig. 11, and their mode of engagement with the palls, I, is advantageous for strength and certainty of action. The annual ratchet, K, forms the eye or large end of the lever, L. M is the pall disk, containing the four sliding palls, I, actuated by the spiral springs working partly in their hollow interior. This 'differential' or 'vernier' arrangement of palls and teeth also gives the desideratum of strength, combined with fine division of the circle into frequent stops or engagements.

Fig. 6. *The Swivel Brace.*—This brace may be actuated with the lever, N, at any angle whatever, by vibrating it in the ordinary way, or with a sinuous, circular, or any other regular or irregular motion, to avoid obstacles and suit the case and convenience of the operator. The details are shown more plainly in figs. 12, 13, 14, and 15. The pall barrel or cylinder, O, has within it four sliding palls, P, the spiral springs of which are sunk in them. The ratchet wheel, Q, has five strong teeth giving a differential action with twenty stops or engagements in a revolution. The brace has the customary feed screw and nut, R. The lever, N, may be removed by withdrawing the pin or stud, S; and by passing a bar of convenient length through the holes previously occupied by the pin, S, a double-ended lever is thereby formed, at the opposite ends of which two workmen may simultaneously apply their force. This is of service where great despatch is requisite, as in the case of breakages of machinery or repairs.

The Carpenter's Ratchet Brace.—This brace is to be used in combination with the common swing brace, for confined situations where the swing brace cannot be rotated in the usual way. The ratchet action is similar to that of figs. 6 and 12, being wholly contained in the cylinder, T. Either a right or left hand ratchet motion may be given by sliding the small bolt, U, into gear, with the lower or right hand ratchet to give a left hand motion, as shown in fig. 7, or by sliding it in gear with the upper or left hand ratchet wheel to give a right hand motion. There are two sets of the sliding palls within the cylinder, T, of similar kind to those in fig. 12, one set working downwards into the right hand ratchet wheel, V, and the other set acting upwards against the left hand ratchet, W, on the back of which is a square shank, X, to fit the common carpenter's or swing brace. The parts of these brads are interchangeable and case-hardened.

MECHANIC'S LIBRARY.

Builder's Price Book for 1868. Atchley. 12mo, 4s., cloth.
European Armaments in 1867. Brackenbury. Crown 8vo, 5s., cloth.
Hints on the Qualities of Gold. Streeters. 12mo, 1s., cloth.
History of the Art of Printing. Humphrey. Imperial 4to, £3 3s., cloth.
Instructions in the Art of Lithography. Royal 8vo, 7s. 6d., cloth.
Principles of Chemistry. Nagnets. 8vo, 25s., cloth.
Purification and Utilization of Sewage. Latham. 8vo, 2s. 6d., sewed.
Reservoir Designing. Jacobs. 8vo, 2s., sewed.
Telford's Life. Smiles. Crown 8vo, 6s., cloth.
The Art of Wood-carving. Rogers. 4to, 5s., cloth.
Waterworks of London. Colburn & Marr. 8vo, 7s. 6d., cloth.
Wonderful Inventions. Timbs. Crown 8vo, 5s., cloth.

RECENT PATENTS.

TREATING JUTE, HEMP, AND FLAX.

W. P. Butchart, *Dundee.—Patent dated 6th April*, 1867.

The first part of this invention relates to an improved arrangement or construction of mechanism by which jute, hemp, flax, or other fibrous substances, are treated for the purpose of thoroughly separating and disintegrating the fibres of which such substances are composed. The mechanism is carried in a rectangular framework of cast iron, and it consists of several sets of fluted rollers, the under or lower ones of which are of much greater diameter than the upper ones. The end main lower roller is that to which motive force is first applied. It is driven by a belt passing over a pulley or a shaft situated near to the rollers; spur gearing, however, intervening between the pulley shaft and the roller, in order to reduce the speed of the latter to the required extent. On the side of the roller opposite that from which it is driven a bevel pinion is keyed, which gears into a corresponding bevel pinion or wheel on a horizontal shaft, which is carried in bearings on brackets projecting from the side of the framing. This shaft has a series of

WESTON'S PATENT DIFFERENTIAL RATCHET BRACE.

NETTLEFOLD & CHAMBERLAIN. MANUFACTURERS.

BIRMINGHAM.

Fig. 1.

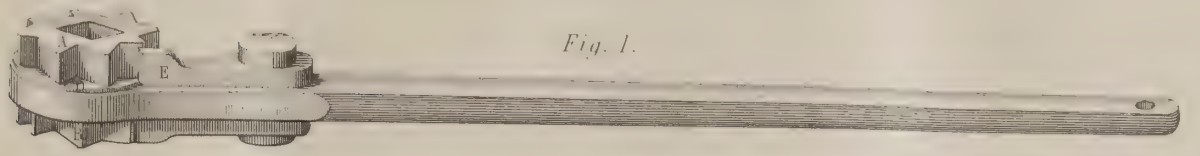


Fig. 2.

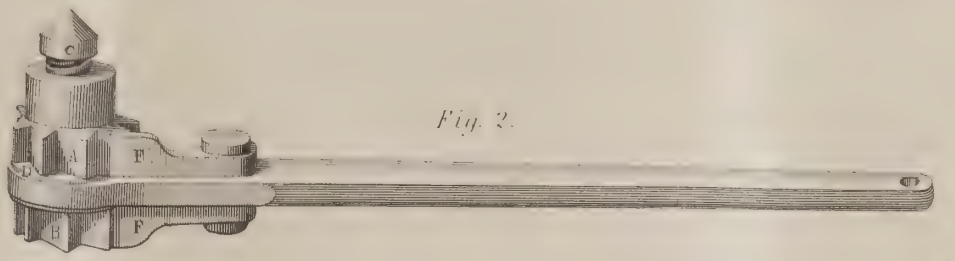


Fig. 3.

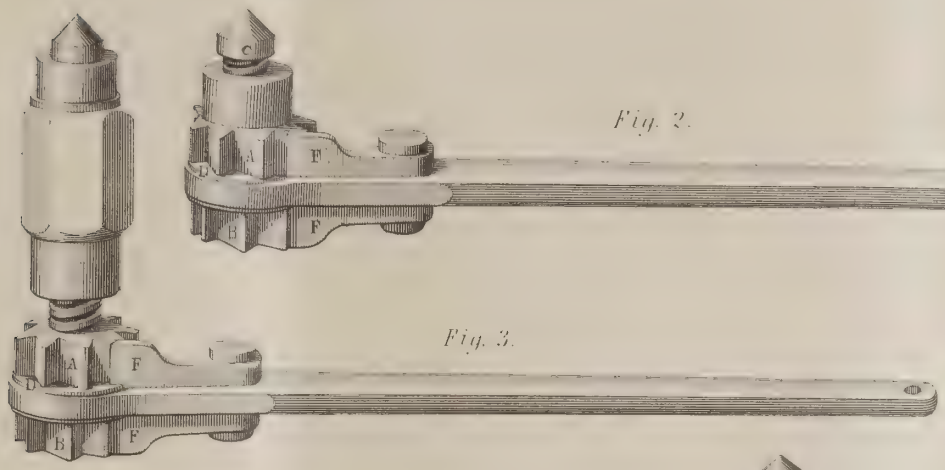


Fig. 6.

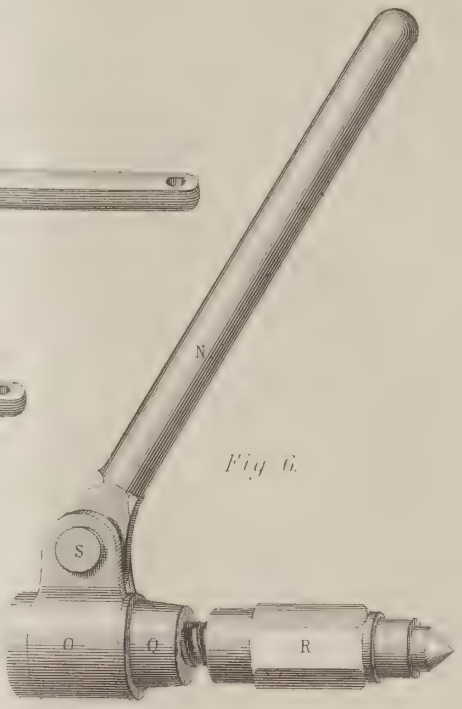


Fig. 4.

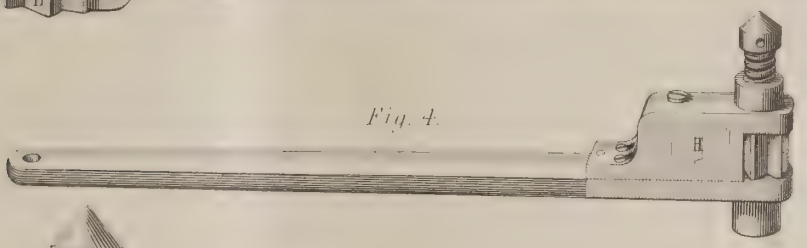


Fig. 5

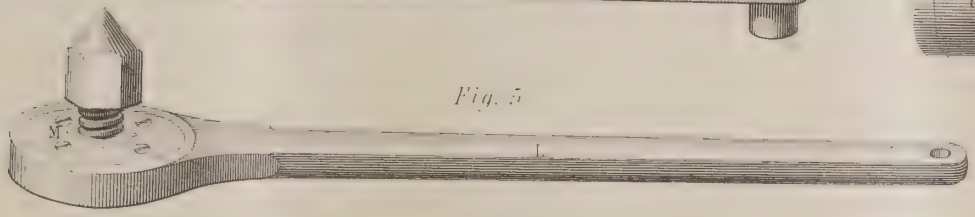


Fig. 7.

Scale of Figs. 1 to 7 - ⅓ full size
8 to 15 - ½

Fig. 8.

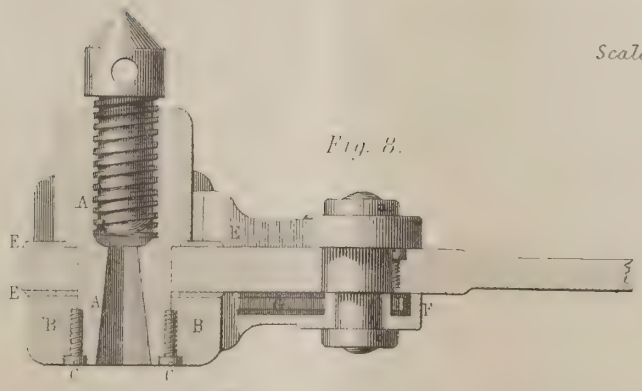


Fig. 10.

Fig. 9.

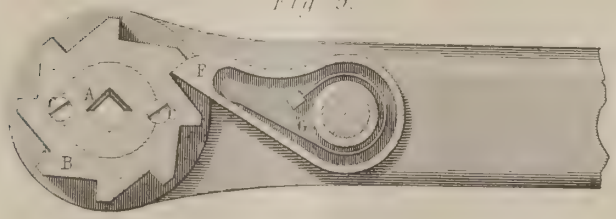


Fig. 11.

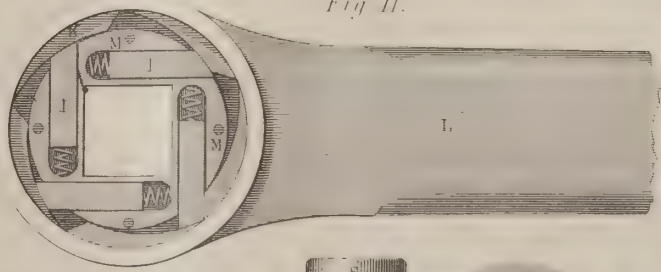


Fig. 15.

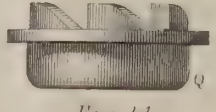


Fig 14.

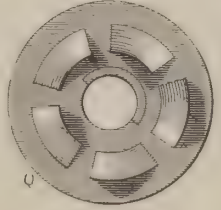


Fig. 13.

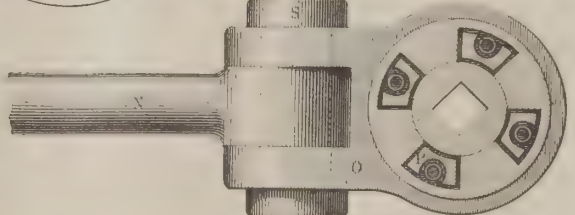


Fig. 12.

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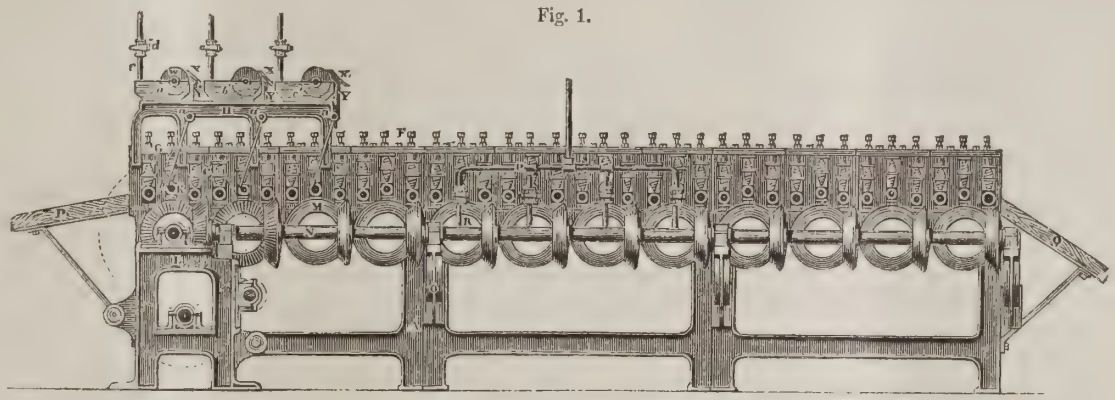
bevel pinions or wheels on it at intervals for the purpose of driving the several sets of softening rollers, a bevel pinion being secured on to the axle of every lower roller in the series, by which each set of rollers is rotated. Of the upper rollers there may be two or more to every large lower roller; their journals are fitted with adjustable slide bearings acted on by helical or other springs, to produce the necessary pressure on the material being softened. When the machine is set in motion, the substance to be softened is fed into it from a feeding table at one end, and being continually advanced forwards, comes at the opposite end in a softened and disintegrated state. The softening is, however, promoted very considerably by the use of that which constitutes the second part of this invention, namely, the means or apparatus for distributing the softening liquid or liquids. Over each set of the fluted rollers a trough is situated in which a distributing roller is kept revolving, it being actuated off some convenient revolving part of the machine by spur or other gearing. Of every three such troughs one contains oil, another water, and another a liquid substance known to manufacturers of textile fabrics as anti-mildew. As the rollers revolve in the troughs containing these liquids they lift a small quantity of each of them; and in front of each roller a distributing plate is situated, being cut with teeth or points on the upper and under sides for the purpose of causing the liquids to drop on to the material as it travels through the machine in the form of evenly distributed drops in place of a broad and uneven stream. The distribution of the liquids is stopped instantly that the material has passed through, or when no material is being softened, as the distributing plates are fixed on the upper end of a pair of levers, one of which is extended downwards and terminates in a spanner, which spanner is pushed on one side by one of the top rollers as they assume their lowest position when there is no material between them and the under roller. The troughs containing the liquids are provided with a float valve for regulating the flow of the different liquids from the tanks in which they are contained, so that the level of the liquids in the troughs is maintained constant, or nearly so. The rollers for raising and distributing the liquids may have their distributing effect increased by forming inclined holes in their surface, which fill with liquid as the roller is rising up, and on overturning empty themselves

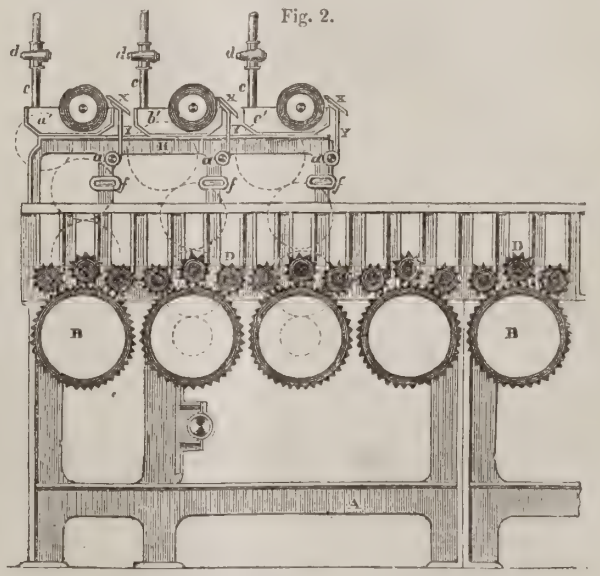
Fig. 1.



over the distributing plates above referred to. The distributing rollers may be arranged in pairs to distribute two liquids in a compound set of streams or drops, and in this way may be very conveniently applied to some classes of softening machines at present in use. Some of the softening rollers may be heated by admitting steam, hot air, or hot water into their interiors from a hole at the centre, at which place a pipe is united for the admission of the heating medium by a joint which is free to allow the roller to revolve. By heating some of the rollers in this way the softening effect is enhanced. The apparatus for actuating the distributing rollers is provided with a set of change wheels and pinions, so that their speed, and therefore the quantities of liquid distributed, may be varied to suit any material under treatment. As the roller used for distributing the anti-mildew liquid is liable to corrosion from that liquid, it is intended to cover it with lead, on which metal the action is of less intensity.

Fig. 1 of the annexed engravings is a complete side elevation of the machine, fig. 2 a longitudinal section of part of the machine, and fig. 3 an end elevation of the feed end of the machine. In the following description the same letters of reference apply to all the views. In fig. 1 A is the main framing, on which is carried in suitable bearings the lower set of fluted rollers, B. On the top of the main framing the guide framing is bolted, for the purpose of carrying the upper set of fluted rollers, D, and also the helical springs which communicate the requisite amount of pressure to the upper rollers, and which pressure may be increased or diminished at will by the set screws, F, which are situated in the covers, G, bolted on the top of the guide frames. To the side of the guide frames are bolted the frames, H, for carrying the troughs containing the liquids relating to the second part of the invention, and which is hereinafter more particularly described. J J′, fig. 3, are the fast and loose pulleys by which the machine is driven, the power being transmitted through suitable gearing to the spur wheel, K, which is keyed on the spindle of the first of the under set of rollers at the feeding end of the machine, the shafting being carried on the main framing of the machine and the stool bracket, L. The remainder of the lower rolls are driven by mitre wheels keyed upon a shaft, N, extending along one side of the machine, similar wheels being keyed on the ends of the lower rolls. The shaft, N, is driven from the spindle of the first roll by mitre gearing; these being made of greater pitch, as shown in fig. 1. At suitable distances along the side of the machine brackets, O, are bolted for carrying the shaft, N. P is the table upon which the jute, flax, or other substances, are laid for being fed into the machine, and Q is the table upon which the substances are delivered, after having passed between the fluted or softening rolls. P′ is a pipe extending along the side of the machine, to which may be

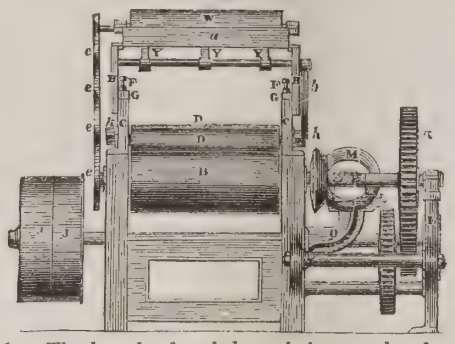
Fig. 2.



connected by pipes, R, fig. 1, any number of the lower rollers, so that steam may be admitted to the interior of the rollers. The second part of the invention, viz., the machinery for applying the liquids used to assist in the disintegration of the jute, flax, or other fibrous substances, consists as follows:—Referring to the engravings, H is the framing on which the troughs, V, which contain the liquids are carried, the first trough, a', containing water, the second, b', oil, the third, c', the liquid known as anti-mildew; W, the rollers which lift the liquids and convey

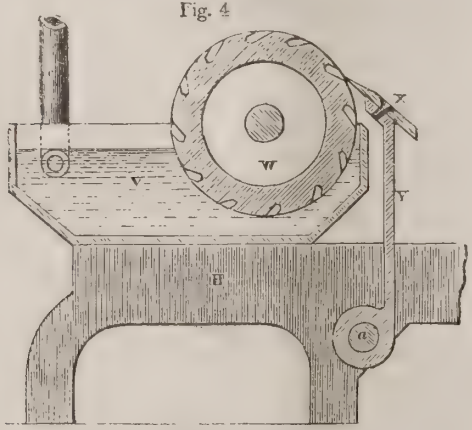
them to the distributing plates, X; these plates are made of brass or other material, and are grooved on both sides so that the liquids may drop uniformly over the material being softened, instead of in an uneven stream. The plates, X, are screwed to the levers, Y, keyed on the transverse shafts, *a*; on one end of each of the shafts a lever, *b*, is keyed, terminating in a curve, *h*, at the bottom end, as more particularly

Fig. 3



seen at fig. 1. The length of each lever being regulated so that when the machine is not in motion, and the upper fluted rollers are in their lowest position, the ends of the levers are in contact with the projecting ends, *k*, of the journals of the rollers, D, at a point on the line of their horizontal diameters, and each lever being thus held back, the grooved plates, X, are lifted from contact with the rollers, W. When the machine is in motion, and jute, or other material, is passing between the rollers, the upper ones are pushed up, and consequently as the centre of the bearings rise above the curved end of each lever, the lever falls forward by its own weight, and the plates, X, come into contact

Fig. 4



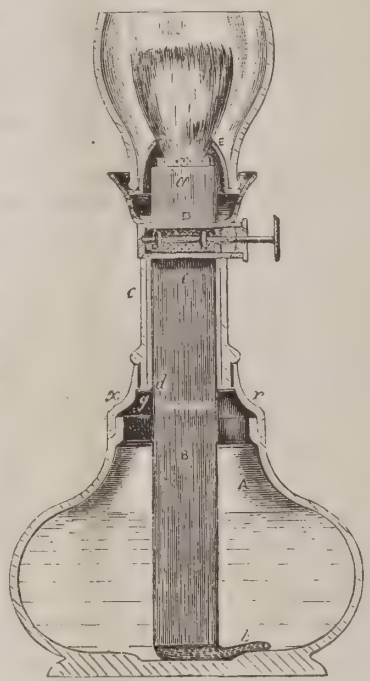
with the rollers, W, in the troughs, so that the quantity of liquid removed from the rollers, W, by the plates, X, is regulated by the quantity of jute, or other material, passing between the fluted rollers. The pipes, *c*, for supplying the liquids to the troughs are provided with taps, *d*, so that the liquid passing through any of them may be turned off altogether, and for keeping the liquids at the proper height in the troughs ordinary ball cocks are used. Fig. 4 is a transverse section of one of the troughs. In order to increase the power of the rollers for lifting the liquids, holes may be formed on their surfaces, as shown. Each of the rollers is provided with a set of change wheels, *e*, as shown on figs. 1 and 2, carried in slot brackets hung on a stud to the loop, *f*, fig. 2; by means of these change wheels the speed of the distributing rollers may be increased or diminished at pleasure. The mode of working the machine is as follows:—The machine having been set in motion, the fibrous substance to be softened is placed on the feed table, P, and fed in to the first rollers; immediately it passes under the rollers in contact with the lever, *b*, the roller is lifted up, the lower end of the lever falls forward, and the grooved brass plate, X, comes in contact with the roller, W, and the liquids drop upon the fibres. The steam having been admitted to the lower fluted rollers through the branch pipes, R, exhausts by the pipes, S, passing under the machine, and escapes by the perforations, T, assisting in softening the substances passing through the machine. After passing under the rollers the fibres pass out at the delivery table, Q.

LAMPS.

J. Henry Johnson, *London and Glasgow*. A Communication from Adrien Muller & Ignace Mathei, *of Paris.—Patent dated 20th February*, 1867.

This invention has for its chief object the utilization, for the purposes of lighting and heating, of those hydrocarbons which, by reason of their highly volatile nature, have hitherto been considered inapplicable (compatible with safety) to the purposes above referred to. One mode of utilizing these volatile hydrocarbons, or light mineral oils, consists in carburetting atmospheric air, by causing it to permeate several chambers in which cotton or other suitable absorbent material saturated with volatile oil is contained, the air passing in a zigzag or serpentine course through such chambers, from the top to the bottom of the series, whence it issues in a condition fit for use, either as an illuminating or heating agent. These chambers are disposed in tiers in a closed outer casing, each alternate chamber being of rather smaller diameter than the interior of the outer casing, whilst the chamber beneath is of the same diameter as the interior of the outer casing, but is provided with a central perforated passage for the supply of air to the chamber below. Those chambers which are not provided with a central opening, are perforated at the outer sides in order to allow the air which enters them at the centre to pass through the perforated sides to the next chamber below, whence it passes through the central opening into the chamber beneath, and so on; the course of the air being alternately from the centre towards the periphery and *vice versâ*, as it traverses the several chambers. The perforations are all disposed some little distance above the bottoms of the chambers, in order to allow a sufficient quantity of the hydrocarbon to be contained therein to maintain the absorbent material thoroughly saturated. The hydrocarbon is introduced by a pipe and stop-cock at the top of the casing, and flows from one to another of the chambers, any overflow from the bottom chamber being collected in a reservoir or well, and drawn off from time to time. The air enters by a pipe and stop-cock at the top of the case, and issues in an inflammable condition by a corresponding pipe and stop-cock at the bottom leading to the burners.

Fig. 1.

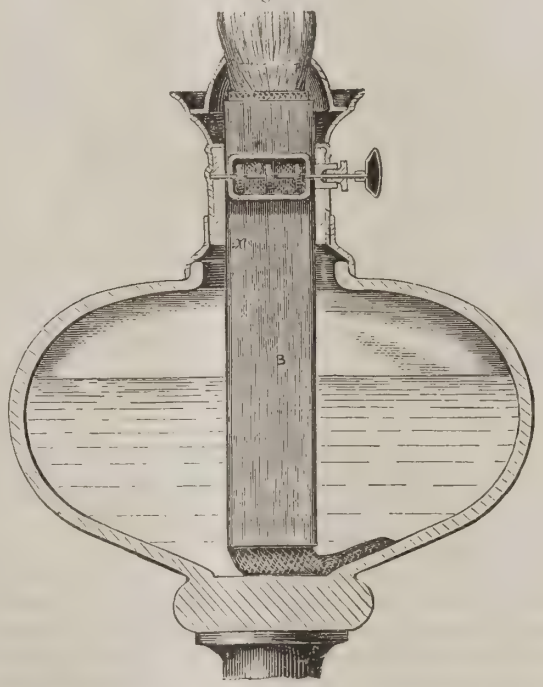


With a view to burning light or volatile hydrocarbons, it is proposed to construct a special form of lamp in which the wick tube descends to the bottom, or nearly to the bottom, of the oil reservoir, so as to entirely exclude all air from the interior of such tube. The wick elevator is contained in a stuffing-box filled with asbestos, so as to prevent the admission of air at that part, and the wick tube itself is inclosed in a column of plaster of Paris, or other good non-conductor of heat, contained in an outer tube screwed on to the reservoir, whereby the latter is kept cool. The arrangement of the actual burner may be similar to an ordinary hydrocarbon lamp. As the reservoir is maintained perfectly air tight, it is proposed to make two small perforations in the wick tube above the level of the oil, in order to afford a safe exit for any undue pressure which might arise inside the reservoir by reason of the elevated temperature of the surrounding atmosphere in the apartment. This construction of lamp is equally applicable to lamps intended for burning the ordinary hydrocarbons, but in that case the burner may be brought nearer to the reservoir; and as the ordinary hydrocarbons do not volatilize under a temperature of about 90° Fahr., the safety holes in the wick tube, which are requisite when using highly volatile oils, will not be required.

Another form of lamp suitable for burning highly volatile hydrocarbons in the form of vapour, consists of a reservoir in which the wick tube (by preference of a round section) descends, as before mentioned, to the bottom, so as to exclude air from the wick. This tube contains a solid round wick. A perforated metal cap is screwed on to the upper end of the wick tube, the inflammable vapour issuing through such perforations and being burnt in the form of gas. As this cap becomes highly heated, the hydrocarbon is volatilized as fast as it rises up the wick, and hence a constant light is obtained.

Fig. 1 of the annexed engravings represents a sectional elevation of a lamp constructed according to another portion of this invention, with a view to the burning of light or highly volatile hydrocarbons. A is the reservoir, and B a flat tube within which is contained the ordinary petroleum flat wick. This tube descends to the bottom of the reservoir, A, below the level of the sides of the small well or cup, *b*. This tube, from its lower extremity, *b*, to its upper end, *a*, has no communication with the external atmosphere. The wick elevator, D, is carefully shielded from the atmosphere by a stuffing-box packed with asbestos, *e*, through which the spindle carrying the toothed wheels of the elevator passes. The column, C, is screwed on to the reservoir, A; it carries the wick tube, B, and from *f* to *d* is filled with plaster of Paris, which is poured therein, or with any other good non-conductor of heat, which prevents any communication, excepting through the wick, between the interior of the reservoir, A, and the burner, E, of the lamp, which burner may be similar to an ordinary petroleum burner. The plaster also serves to prevent the transmission of any heat from the burner to the reservoir. Under these circumstances the wick immersed in the reservoir will enable the volatile hydrocarbon to ascend readily by capillary attraction to the top of the wick. The liquid burns the same as petroleum. The reservoir is absolutely protected from all risk of explosion, as any flame which might descend by the wick cannot reach the explosible space situate above the level of the liquid in the reservoir.

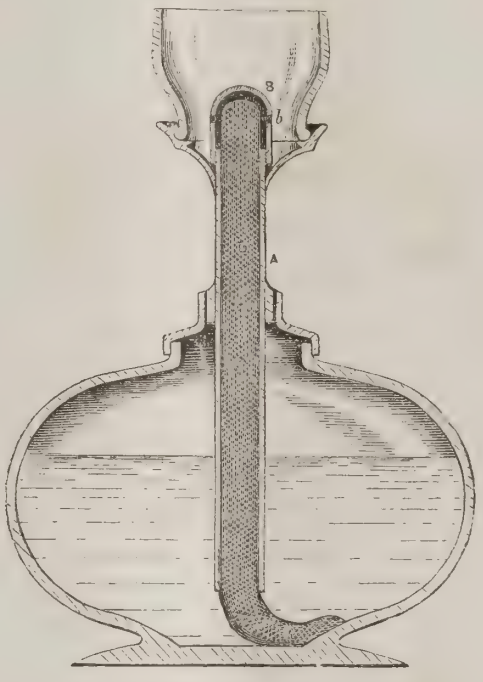
Fig. 2.



Two small perforations about the size of a pin are made at *g* in the wick tube, in order to prevent any pressure within the reservoir, should the temperature of the apartment be sufficiently elevated to cause any excess of vapour to form inside the reservoir, and to produce a pressure which would tend to force the liquid up the wick too freely. It is equally impossible for the flame to communicate with the reservoir through holes of the small diameter indicated. By increasing the height of the column, C, the same lamp will be equally applicable to the burning of naphtha.

Fig. 2 represents a sectional elevation of the inexplosible lamp adapted to the use of petroleum. The insulating column is considerably shortened, or even replaced, by a disc, *x*, intercepting all communication of the flame with the reservoir. It differs only from the ordinary lamp in the use of a wick tube, B, descending into the liquid, and the addition of an asbestos stuffing-box, *e*, for the passage of the spindle of the elevator, by which means the most highly explosible petroleum will be completely protected from all risk of ignition. As petroleum emits no vapour at a temperature below 90° Fahr., there will, under ordinary

Fig. 3.



circumstances, be no pressure in the reservoir, and therefore the two escape holes, *g*, may in this lamp be dispensed with. This lamp is specially intended for burning ordinary petroleum oil.

Fig. 3 is a sectional elevation of a lamp which is specially adapted for the use of the most volatile liquids. It contains a cylindrical wick tube, A, in which a solid round wick, D, is introduced. On the top of this tube there is fitted a cap, B, perforated with a number of holes, *b*; the essence or highly volatile liquid rises by capillary attraction up the wick, and the vapour alone of the liquid is burned as it issues through the holes, *b*, in the cap. The heat of the flame is transmitted to the cap, B, which thus assists the vaporization and maintains a steady and constant combustion.

It is to be understood that the lamps may be fitted with any of the well-known forms of burners, whether flat, round, or otherwise.

REVIEWS OF NEW BOOKS.

PRACTICAL HYDRAULICS: A SERIES OF RULES AND TABLES FOR THE USE OF ENGINEERS. By THOMAS BOX. 1 vol. small 8vo. Spon, London. 1867.

MR. BOX, who dates his preface from Grasmere, and is, we presume, engaged in practice in the north, has produced a very good and useful little volume. It is one intended, not for teaching, but for use, and wisely never loses sight, as most English pocket-book makers do, of this distinction. It has one grievous defect as regards its practical use, but one which the publisher can easily supply in a second edition: it has *no index*, and there is so much matter, and so closely put together, that this must prove an inconvenience.

None of the tables given are very new, but they are well chosen and usefully arranged, and the connecting paragraphs of text are lucid and to the point in general; but, on the grounds we started with, this volume is only of use to one who knows his hydraulics as a science beforehand.

We have noticed one or two little slips; *e.g.*, at page 38, referring to comparative resistance, in smooth cast and in corroded iron pipes, the author says, "But some waters, especially those from the granite formations, contain a great deal of *oxygen*, which rapidly decomposes iron,

forming rust, which is deposited, not in an even surface, but in nodules or carbuncles." Now, carbuncular corrosion, as it was called by French hydraulic engineers who first observed it in the water pipes of Grenoble, is due, not to oxygen, but to *alkalinity* in the water. The passage shows still further inexactness of knowledge as to the relations of air and water in corroding iron. The appendix on the strength of water pipes is deficient of any sufficient formula taking into account the differences between the strain of the inside and outside lamina in a pipe of considerable thickness.

THE ENGINEER'S, MINING SURVEYOR'S, AND CONTRACTOR'S FIELD BOOK. By W. DAVIS HASKOLL, C.E. Second edition, enlarged. 1 vol. 8vo. Lochwood, London. 1866.

THIS is a useful little book in many respects, and worthy the reputation that the author has long enjoyed for a similar class of works in collateral branches of civil engineering, in which his experience has enabled him to become a good teacher. In this second edition one of the prominent features is the explanation and production of tables for facilitating trial levellings by means of the theodolite. These are well described, and the tables well arranged. There is no doubt, as has long been pretty widely known, that theodolite levelling is a *rapid* method; but unless performed with a care that much reduces its rapidity, it is liable to very serious errors, as the levellings done early in the ordnance survey of Ireland showed. At present, over a *great* tract, we should be much disposed, in the first instance at least, to make trial sections of country by means of a first-class and large aneroid barometer. The author seems to ignore any errors due to atmospheric refraction; yet in a hot country these are considerable and by no means constant, and can only be eliminated by taking over the same incline, angles of elevation and of depression; *i.e.*, going over the work twice.

His methods, for which some good tables are given, of setting out curves, by offsets from a single tangent, do not seem nearly so good as that of Rankine, and some others in use. The volume concludes with some very conveniently arranged earthwork tables. It wants an index: the table of contents is an insufficient guide.—ED.

THE ESSENTIAL ELEMENTS OF PRACTICAL MECHANICS, BASED ON THE PRINCIPLE OF WORK. Designed for Engineering Students. By OLIVER BYRNE, late Prof. Math. Coll. for Civil Engineers, &c. 1 vol. small 8vo. Illustrated. Spon. 1867.

WE can say nothing in praise of this work, but that the publisher has brought it out in his accustomed style of good paper, print, binding, and illustration. "This work," says the author in his preface, "is designed to make good a deficiency much felt by practical engineers and engineering students, . . . who, to understand the treatises on the theory and application of mechanics, employed as class books in our schools and colleges, *require considerable mathematical skill;* and after all, the elementary knowledge acquired by studying such works is of little value to the practical engineer. On the general theory of mechanics there are many popular works, *clear of mathematical formulæ* and serviceable to the general reader, but *the practitioner cannot render them available.*" Again, "*French investigators and writers on practical mechanics take for granted they are addressing those who understand the theory of mechanics,* and when their works are copied or translated they are far from being elementary."

Mr. O. Byrne, however, undertakes to cut through all this entangled knot of difficulty for his *uneducated readers* by this work, in which "the essential elements of practical mechanics are based upon what is termed *the principle of work.*" Was ever there such a jumble of thought and word? Works on mechanics clear of any mathematics are admittedly of no use: students in Great Britain cannot understand the school and college class books on mechanics put into their hands for want of a little sound elementary mathematical knowledge, which elementary knowledge is nevertheless of very little value to the practical engineer. Yet French authors on practical mechanics do actually address their readers on the assumption that they have been educated up to the point necessary to enable any one to enter the temple of exact science by any portal, however lowly. To remedy all this, what is Mr. Byrne's recipe? Teach practical mechanics, setting out from the principle of *work:* that is to say, simplify matters to the unlearned by starting with *dynamics,* and mixing up dynamic considerations with every proposition of pure statics or of hydrostatics, however simple, and so simplifying by complexity.

The result is evident enough to any one who knows the lucid, facile elegance and easy comprehensibility of almost any elementary treatise on applied or theoretic mechanics, let us say Boucharlat's "Mécanique," and who just glances through Mr. Byrne's confusing and inelegant pages, from which no mere learner could ever obtain anything as to mechanics, but a mass of confused and disjointed notions, and to which no one who had learned mechanics at any true fount of knowledge would ever turn as to a text-book for information.

It is a bit of the old story, still, unfortunately, credible to multitudes in Great Britain, that there is some royal road to *practical* knowledge, without being troubled with the straight-laced requirements of the school or the theorist. The sooner it becomes *incredible* to every student, boy, man, engineer, mechanic, in the three kingdoms the better for them, and for us as a nation. Let them endeavour to discern the reason and results of what Mr. Byrne so truly, though so inconsistently, confesses, that French writers on *practical* subjects of mechanism and engineering treat their questions in the only way in which there is any use in treating them at all, viz., *secundem artem,* and address men who have been duly trained in the rudimentary knowledge without which no man can understand, much less progress, in such studies, or be more than one groping in the dark. This is what *technical education* really means; not *special* education—such as a cobbler's apprentice receives when he is taught to stitch a sole, or a glazier's boy when he is taught, like a monkey, *the rule* of cross multiplication to enable him to cast up glazed work—but rudimentary education, starting off from the platform of mere primary knowledge, reading and writing, &c., in various separate directions, having each in view a distinct ultimate aim and practical object of study and pursuit in life. To the engineer or mechanician this necessarily starts off in the direction, chiefly and mainly, of geometry, algebra, mechanics, physics, and chemistry.

Mr. Byrne's book affords no bad commentary upon the indistinctness with which this is recognized amongst us. We cannot avoid noticing, too, that the volume is not free from a good deal of *charlatanerie.* In the preface we are told the author has introduced *a simple notation and a new system,* to enable the student to master with ease the principle of work, "discarding the denominations *foot-pounds* and *kilogram-metres,* which are evidently improper!" What, think ye, is the new system and simple notation? Nothing more than this, that wherever in the book a *big* figure in Egyptian *black* type, thus, **24**, occurs, it means so many units of *work,* and becomes related to *time* by the addition above of the dashes representing seconds or minutes! and so the pages are given a strange look, populated thickly in numbers of arithmetical examples by these nigger figures. But when something *has* to be expressed by formulæ, the "auld-warld" notion and expression for work, in the well known foot-pounds, comes out as slick and unnoticed as if nothing had been so absurdly said to condemn it: *e.g.*, at page 128, units of work in a cannon shot = its weight in pounds multiplied by $\frac{V^2}{2g}$, g being $= 32\frac{1}{6}$.

It is, however, not worth while to waste space in further remarks on this work, in which we remark the author has hauled in his cumbersome and useless "*dual arithmetic,*" now many years before the world, but with no significant results.—ED.

A TREATISE ON THE ART OF CONSTRUCTING OBLIQUE ARCHES WITH SPIRAL COURSES. By W. DONALDSON, M.A., Cantab, Ass. Inst. C.E. 8vo, plates. Spon, London. 1867.

THE title should rather have been a treatise on the theory, than on the art, of constructing oblique arches. It is, in fact, a brief development of a few of the more usual or important problems of skew bridge construction, starting from the properties of the screw thread or spiral, and by the methods of rectangular co-ordinates.

As a students' book it may be useful; and to one who has mastered the principles and methods of skew arch construction, as given in several more or less elaborate works, both British and Continental, it may be of use to be looked through, with a view to clear and bind together his knowledge: but it is not of any service to the practician, to whom graphic methods will, in this as in every other department of complicated masonry, prove of most value, when once the principles upon which these rest have been clearly comprehended.

CORRESPONDENCE.

☞ We do not hold ourselves responsible for the views or statements of Correspondents.

(To the Editor of the Practical Mechanic's Journal.)

SIR,—Being a constant subscriber to your valuable Journal, and knowing that you are greatly interested in the manufacture of iron and steel, I shall be glad if you can inform me if steel castings are annealed in the same way as malleable-iron castings; viz., by inclosing them in iron cylinders with substances which absorb carbon, or merely subjected to a red heat in a furnace without being inclosed in the way described. I shall also be glad if you can inform me which are the best kind of annealing furnaces. I shall be obliged if you can reply to these questions in your next issue.

Yours truly,

WOLVERHAMPTON, *December* 10, 1867. SAMUEL MARSH.

P.S.—I have been lately making some experiments in the manufacture of steel, which I have every reason to believe will be of great value. The results I will shortly communicate to you.

[The effect of annealing of cast iron by the method employed by the founders of malleable castings is to remove, by cementation, more or less of the *uncombined carbon*, chiefly diffused through the mass of ordinary cast iron in the state of plates or scales of *graphite*. As cast steel, whether Bessemer or other, scarcely contains an appreciable quantity of such uncombined carbon, it is obvious that annealing it after the above fashion can have no similar result. The effect will be limited to such softening and toughening as all steel undergoes, when heated to a sufficient temperature and suffered *slowly* to cool. Oxidation will be avoided by annealing, *i.e.*, softening, steel in close vessels or immersed in ferruginous sand. By sufficiently *prolonged* heat, continued at a high temperature, probably changes both in molecular and chemical qualities may be induced in steel; but this is not the point of Mr. Marsh's enquiry.—ED.]

PARIS EXHIBITION. (BRITISH EXECUTIVE.)

REPORT ON CLASS 53, GROUP VI.

MACHINES AND MECHANICAL APPARATUS IN GENERAL.

By ROBERT MALLET, C.E., F.R.S.

A CRITICAL report upon the vast and very various collection of objects embraced in this class must assume the dimensions of a treatise, and to be exhaustive, would involve several such. All that is here attempted is to give, in a condensed and popular form—1st, some notion of the principal kinds of objects exhibited in this class; 2nd, to signalize the main points of improvement observable as having been effected during the last decade in some of the more important of these objects; 3rd, to notice briefly some of the objects of chief curiosity or interest in this class that may engage the observer's attention.

Whilst machines and mechanical apparatus (that is to say, the material contrivances by which force and motion are transmitted, transferred, or modified in direction in *space*, or in their mutual relations to each other in regard to *time*, for this is all that machines other than those which deal with molecular forces—electricity, heat, light, magnetism, &c., can do) admit of some great classifications in relation to the specialty of their objects, such as machine tools, machines for spinning, weaving, paper-making, &c., there yet remains, in virtue of the multiplicity of aims and objects of human industry, a vast mass whose ends and purposes are so various and distinct, each from each, as to admit of little more convenient classification than to group them together under the very general and somewhat vague title of this Class 53. But besides this great and heterogeneous mass of machines, apparatus, and contrivances—some of the two latter of which pass away occasionally from machines at all, as above defined—the Class 53 in the Paris Exhibition of 1867 has been caused to embrace all prime movers, of whatsoever sort, which are *not in motion, nor engaged in supplying power* for actuating exhibited machinery, or for pumping water, or for ventilation, or for any other purposes belonging to the Exhibition, or to its buildings or ground. So that whilst steam power to the extent of probably quite 1000 horse, indicated power (that is, each horse-power being reckoned by 33,000 lbs. being lifted to the height of 1 foot in each minute of time), is employed in doing *work* for the purposes of the Exhibition, and the engines so *working* are relegated to Class 52, a much larger number of engines *not at work*, and possessing a total probably of much greater horse-power, are included in this Class 53.

The objects then of Class 53 may be divided into five or six groups, and classified in something of the order of their relative importance, as follows:—

Group I. All first movers (not in activity) whose effects depend upon the direct conversion of molecular forces into mechanical ones, viz.; steam engines, gas engines, air engines or caloric engines, as these are often called, and engines dependent upon the evolution or expansion in volume of gases, such as ammonia. In this group is embraced all the parts, direct or ancillary, of these machines; steam boilers of many sorts, and all their numerous adjuncts, such as safety valves, manometers, water gauges, feed pumps, injectors, are here found, as well as smoke-preventing arrangements; and as transmitting the power from the engine, or assisting in its motion or management, we have shafting and gearing, the bearings of these, and the various arrangements for lubricating these, automatically or otherwise, governors, or other regulators of speed, and many other detached arrangements related to the working of engines.

Group II. All first movers (not in activity) which render available for human uses some fragment of those mechanical *active* forces as found pre-existent in the world around us, and which nature herself in the order of the universe has already converted into such, from the molecular force given forth from the sun: these are (A) machines recipient of water power, *i.e.*, of the power derivable from the fall by gravity of a certain weight of water, per second, from a higher level, to which in some way it has been pumped up by the sun, to a lower level; and embrace water wheels acting by weight, with or without impulse, of whatever sort; turbines, acting by reaction, and water-pressure engines, acting by fluid pressure, usually on a piston; or (B) they are machines recipient of the power of atmospheric currents, due to disturbance of equilibrium in the atmosphere produced by the sun—such as wind mills, &c.

Group III. May be formed of all sorts of machinery intended for overcoming gravity of *solid* bodies, *i.e.*, for lifting such—comprising cranes and all sorts of lifts and of hoisting tackle, whether fixed or movable, and whether actuated manually or by power.

Group IV., in the same way, embraces all sorts of machines for overcoming gravity in *liquid* or *fluid* bodies, such as pumps of every sort, piston, centrifugal, chain, norias, &c., &c.; and in many different and special applications, such as to the supply of cities or houses, for drainage, for irrigation, and many others, including fire-engines, and whether actuated manually or by power.

Group V. includes an immense variety and number of machines or apparatus for the weighing or cubical measurement of solids, liquids or gases, and whether continuously (on new quantities) or not, and with or without mechanical registration of measure or weight, or of both. This embraces all sorts of balances (other than those for the purposes of science or liberal arts) and weighing machines, water meters, and gas meters.

Group VI. may be constituted of machines or arrangements destined for the transference of work, *i.e.*, of force and motion together in any direction, to great distances. This would embrace hydraulic connections, straps, bands, wire rope, or clip pulleys, and the telodynamic wire of M. Hirn.

There remains a vast mass of contrivances within this class, which though more or less occupying one or other of these latter groups, as having other possible applications or ends than those for which they are directly exhibited, might be with equal propriety described in some other class. This is no fault of the classification or arrangements so lucidly and well made by the French Executive of the Exhibition; it is a difficulty inherent in every attempt to classify the gigantic mass of human productions; and of the same nature as that experienced in the cataloguing of every great library; and in either case, if there is to be either classification or catalogue at all, these can only be, by now and then a little violently cutting the knot of difficulty of perfectly systematic arrangement.

As regards the localization of the objects exhibited in this large class, a proponderant portion of all its groups is placed in the great machinery zone of the main building; the hydraulic first movers, the pumps, and many other objects, in the annexes upon the Quay of the Seine.

The cranes are found on the quay, and in the park, as well as in the main buildings. The locomobiles are chiefly in annexes in the park, divided amongst the respective nationalities. There many stationary, fixed or semi-fixed (*i.e.*, nearly independent of masonry foundation) steam engines also are found, but the greater number of these are in the machinery zone. The fire engines are chiefly in the latter locality, but not confined to it. The wind mills are in the park. The weighing apparatus, and much small apparatus is in the machinery zone, but some large weighing machines are external to the main building. More precise designations of locality are impossible, for objects of Class 53 will be encountered in every part nearly of the display.

The steam engines of this class may be separated into fixed and portable, the latter not including railway locomotives, which are in Class 63, but embracing locomotives for common roads or highways.

The fixed or stationary engines are of three or four principal types, viz., with vertical cylinders, direct acting, or through the intervention of a vibrating beam or lever, with horizontal cylinders, with inclined cylinders, with oscillating cylinders. Again, in any of these types, the engines may comprise a single cylinder, or two cylinders, one receiving high-pressure steam, which expands into the second cylinder, on what is frequently known as Woolf's principle. Lastly, on any one of these several types there may be a single engine, or a pair of coupled engines, acting conjointly. And in all these forms the engines may be either condensing or non-condensing. Rotatory engines constitute a distinct class.

In 1862 one of the most noteworthy circumstances observable as to the engines then exhibited, by both British and foreign makers, was the prevalence of the type of horizontal cylinders. Some double-cylindered engines were also shown; but in general the tendency was evinced on the part of the makers to employ a single cylinder, and to expand the steam in that by a suitable arrangement of valves. In some, but not in many cases, and those chiefly confined to foreign engines, the expansion gear was under the control of the governor. This was markedly the case with the Allen engine, then first exhibited, and which undoubtedly possessed merits not shared by any other engine then shown. Engines of this make are shown on the present occasion. The chief example shown, as being employed within the building, and also without it, belongs to Class 52, though some of smaller power, not doing work, are within our scope.

In these engines, which remain still amongst the very best exhibited in 1867, expansion is effected in a single cylinder by peculiar valves and valve gear, admitting of variable valve motions, produced from a single eccentric. These movements are of such a nature as to realize as fully as perhaps is practicable the conditions under which dry and slightly superheated steam can act upon the piston. The steam admitted at the commencement of the stroke follows the piston at full pressure for a distance which may be as small as we please, and is proportionate to the resistance. It is then cut off without "wire drawing," and the remainder of the stroke is completed by expansion, to within a certain distance of the end of the stroke, when invariably it is discharged through ample areas, and at the instant these are opened compression commences at the opposite side of the piston by the admission of steam.

The arrangements are such, that these engines can run at the very highest velocity that safety will permit, and the Porter governor employed is delicately sensitive in controlling the great energy of the fly-wheel, due to its high velocity. The result is that great uniformity of movement is secured, notwithstanding that

the steam is employed at a very high pressure (3 to 4 atmospheres), and may be cut off at a very small fraction of the length of stroke.

It would be impossible here, or unaided by illustrations, to give an intelligible description of the details of these engines, which are now exhibited as British productions. The employment of high-pressure and slightly superheated steam; quick expansion, varying in amount with the resistance, perfectly effected, yet without condensation at that side of the piston; freedom from back pressure; complete steam jacketting, and perfect condensation, are, so far as the engine itself is concerned, the main points to which theory points as conditions essential to economy of fuel. All these, we have just seen, may be more or less perfectly obtained with expansion in a single cylinder.

It was as early as 1781 imagined by Hornblower that expansion might be more perfectly and advantageously, as well as economically, conducted by passing the high-pressure steam first into one cylinder, and thence causing it to expand into a second and larger connected cylinder, from whence it was withdrawn by condensation. Hornblower was cramped by the existence of Mr. Watt's patent in carrying out his views fully, and it was not until the time of Woolf that the double-cylinder expansive engine, which has taken its name from him, got into much notice. Woolf, and the earlier advocates of this construction, maintained that expansive engines thus constructed possessed *theoretic* advantages over those having but one cylinder. This, however, is a mistake: there is no *theoretic* advantage whatever obtainable by a given amount of pressure and of expansion from a given weight of steam in two cylinders or in one. There are, however, certain *practical* advantages resulting from the double-cylinder construction which, under certain conditions, quite justify its adoption. In a single cylinder the higher the pressure of the steam and the sharper the "cut off," the greater is the inequality of pressure upon the piston during the first and last portions of its course, and the greater the tendency to inequality of rotatory motion against a constant resistance. This inequality, which may become inappreciable in fast-beating engines such as the Allen Engine, becomes a serious evil in the case of engines such as those usually employed to actuate the machinery of factories, in some of which, as in fine cotton spinning, absolute uniformity of rotation is indispensable. Such absolute uniformity cannot be obtained, in the case of high pressure and short cut off, even by the use of very heavy fly-wheels and by coupled engines, where the rate of piston speed is moderate. Now, it may be proved that, with equal steam pressure and equal expansion, the difference of piston pressure at the commencement and end of its course is greater with one cylinder than with two; the piston area in the first case being equal to that of the two pistons acting conjointly in the second, and the capacities of the cylinders being such as to develop equal power in equal times.

Hence, for obtaining the most perfect uniformity of rotation, the Woolf construction with double cylinders is properly adopted. The wide-spread use of this construction as exhibited by foreign nations, as well as in some instances by Great Britain, constitutes the most remarkable feature of this class of the Exhibition. The arrangement of the two cylinders side by side admits of simple valve gearing, and, if judiciously arranged, of little loss of steam in the passages.

There are many engines exhibited of this construction in various forms, which have great merits both in design and in execution. Amongst these we may specify the beam engines of Carels, of Gand, and those of other makers; a horizontal engine, with the high-pressure cylinder inside the low pressure, which is annular around it, by Bergsund, of Stockholm. A steamboat engine, in the Swiss annex, in which the small and large cylinder pistons apply to different cranks of the paddle shafts, is not a favourable example of carrying out this principle in practice. The Corless engine, an American arrangement, in which, by peculiar valve gear, the admission of steam and the cut off are variable and under control of the governor, while the eduction is invariable, and always open and ample at the proper moment, is also shown, not only in its original form as it passed from the United States to Germany, but as modified by Hicks in England. These engines possess great theoretic perfection and beauty of arrangement, but the valve gear is of a nature that precludes anything beyond a very moderate piston speed. A Corless engine in the Swiss annex, by Gebrüder Sulzer, of Winterthur, with double-seated valves and peculiar valve gear, is worthy of attention.

Amongst the other engines which deserve particular notice are the following:—On the grounds of excellence of design generally, or in some particular, or excellence of workmanship and of material, Clayton & Shuttleworth's small horizontal engine, finished with exquisite exactitude and delicacy; Westermann's, of Genoa, marine engines and steam winches, of good sound workmanship; an extremely elegant small vertical high-pressure engine, produced by the Motala Works, Sweden; whence also come some excellently well designed and executed feed or bilge pumps, with hollow plungers. Spain, in the horizontal engines of Fossey & Co., of Guipuscoa, and in the large vertical engine of Alexander Herm, of Barcelona, proves that she can produce motors that are alike respectable in design and in execution. A portable little engine, with vertical cylinder attached to the cylindrical vertical boiler of the latter maker, possesses much merit. Several winding engines for collieries, of Belgian and French make, are well designed and executed machines, and in the special details well suited to their peculiar work. Amongst the large factory engines produced by France, those of Farcot and of Cail & Co. are remarkable. Boyer, of Lille, produces a noble horizontal single-cylinder engine of this class, as do also Gavrian et Fils, of the same town. Several British engines, in addition to the Allen engine, as already noticed, are of fully average excellence, but present no features of peculiar excellence or novelty. Few engines are of more collateral interest than those constructed by the pupils of the state-engineering schools of Aix, Angers, and Chalons, exhibited by the French Ministry of Public Works. A pair of double-cylinder inclined engines by Bourdon, of Paris, deserve notice for the general perfection of the details (which, however, in one or two points, admit of practical improvement), and for the extreme beauty and proportion of the cast-iron vertical framing.

Amongst the engines which possess more or less of interest as departing widely from established types may be mentioned several rotatory engines, none of which even approach the solution of the difficulties inherent in this class, except one from America, which, however, is far from perfect; also, the strange single-acting high-pressure engines of Hicks of the United States, in which the plunger pistons, by the aid of certain perforations and passages in them, are made to perform the functions of their own valves; and Andrews', of the United States, oscillating high-pressure engine, with a curved faced slide, a segment of a cylinder, described by a right line transverse to the cylinder by the oscillation of the latter. This engine actuates an American centrifugal pump, the construction of which is peculiar, and deserves attentive consideration.

The great mass of the locomobile engines exhibited are of average merit. They all evidence advancement in design, and more especially in workmanship, and indicate not only that a better skilled class of engineers are now engaged on these machines, but that better tools are in use for their production than in 1862. There are many details in which improvements might in a more comprehensive report be noticed, but in general design there is little new. In the Swiss locomobiles are several, however, with the Allen engine valve gear applied. The traction engine of Albaret et Cie., of Paris, is in some points worthy of attention.

Amongst the parts or adjuncts of steam engines shown which deserve notice are the spring-suspended ball or centrifugal governor by Pickering of the United States. It possesses the advantages claimed for the Porter governor, with simplicity and small cost. The injectors shown are numerous; that which appears to possess most merits and novelty is the injector of Schaeffer, of Magdeburg, which has the advantage of being constantly charged and ready to inject feed-water, and of being less capable of being put out of order by the careless handling of the adjustments of the central needle cone than in previous constructions. Other simplifications of this important instrument are also exhibited by other makers.

Amongst parts of engines shown, the forgings of the Societe Ansaldo of Genoa demand attention. It has not been hitherto commonly known that Italy could produce, amongst other excellent forgings, a shaft of 22 feet long by 1 foot 6 inches in diameter. Grease cups, grease cocks, valves, boiler and furnace gear in innumerable varieties, and in many instances of great merit, are exhibited, into which space forbids our entering. The boiler, even in its best and most economic form, remains still the worst part of the steam engine. Few boilers of actual size not at work are exhibited; but several models and designs for various combinations or forms more or less pretending to novelty are to be found; and many forms of smoke prevention. None seem to demand (within the limits here prescribed) particular mention, unless it be the "fumivore" apparatus of MM. Thierry et Fils. The action of their apparatus is effective, but its principle is not new. The more diffused application of the regenerative furnace of Siemens will hereafter render the "smoke burning" a thing obsolete.

A remarkable *tour de force* in the way of boilersmiths' work may be noticed as exhibited by Durenne of Paris—a vertical cylindrical boiler, and vertical funnel with two cylindrical transverse flues at right angles to each other, and internal fire-box, all welded into one piece by hand. There are various other *tours de force* shown in this and in other allied classes of the Exhibition, which prove that foreign workmen at present can be found quite as able and adroit as any that Great Britain can produce.

Of the other motors belonging to this class, we can mention here but the gas engines, one of which claims to be an advance upon the Lenoir engine, inasmuch as by an arrangement of singular ingenuity the ignition of the explosive mixture of coal gas and atmospheric air is effected at each half-stroke of the piston by a gas jet always ignited, and external to the cylinder, so that the use of any galvanic apparatus for ignition becomes unnecessary.

Of caloric or heat engines, *i.e.*, those whose power depends upon the alternate expansion and contraction or discharge of a given volume and weight of air or other permanent gas, the most remarkable example exhibited is the engine of Mr. P. Shaw, of the United States. In this engine, which theoretically does not propose to effect more than has been previously done by others, some of the practical or mechanical difficulties hitherto attending all caloric engines appear to be greatly palliated, if not removed.

(To be continued.)

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

SOUTH WALES INSTITUTE OF ENGINEERS.

ON HARPER'S IMPROVED SAFETY-CAGE APPARATUS FOR THE ORDINARY WIRE-ROPE CONDUCTORS. By John P. Harper.

As there have been very recently both papers and discussions on safety-cages before the members of the Institute, I will not encroach on your time in adverting to the different descriptions of apparatus from time to time brought under your notice, the main features of which are well known and understood by all connected with mining operations.

There has been, and is still, great diversity of opinion in this matter, for while some earnestly advocate the general adoption of safety-cages, others are equally prejudiced against them.

Generally we are all agreed so far, that if the apparatus be not a reliable one, in any way easily deranged, or of complicated mechanical construction, the evil sought to be remedied is increased rather than diminished. My safety-cage differs both in principle and detail from any that have preceded it, and certainly stands alone in this respect, that it is specially designed, constructed, and adapted for the ordinary wire-rope conductors.

Safety-cages have hitherto been brought out more particularly for adaptation to the wooden guides, but as these are fast becoming superseded by the iron-wire ones on account of their durability and cheapness, if safety-cages are to be universally adopted, they must be made applicable to the wire-rope conductors.

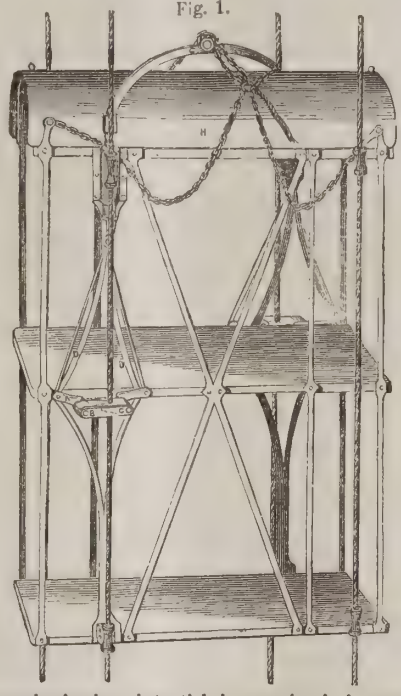
I think, indeed, that safety-cages can be used to greater advantage in connection with the iron-wire than with the wooden guides, for with the wooden ones sharp-pointed or toothed instruments are usually brought to clutch or dig into the conductor; and if it so happens that the length of guide rods on which the apparatus is brought to play be rotten, unsound, infirmly fixed, or in any way defective, the safety apparatus is of no avail: indeed sometimes, be the rods ever so sound and

in good repair, we hear of accidents occurring, owing to the guide rods being split and ripped down by the apparatus brought to bear on them.

Accidents of this description are less liable to occur with the iron-wire guides. I have latterly devoted a considerable time in experimenting upon them, and have found that it would not do to employ an instrument with a sharp point, a toothed or uneven surface, to bear on the conductors; for, as the circumference of a wire-rope is uneven, they would cut and injure the more prominent parts.

The safety-cage which I now desire to call your attention to, answers beyond my most sanguine expectations, acting effectually without damaging or depreciating in the least the wire conductors, of whatever description they may be. The

Fig. 1.



apparatus is extremely simple, substantial, inexpensive in its construction, is not easily deranged, and can be applied to cages and hoists of whatever description or size, whether conducted at the ends, corners, or sides, and carrying any weight. The principle by which the apparatus, on the severance of the winding-rope from the cage, is brought to bear on the conductors is by compression; and its operation

Fig. 2.

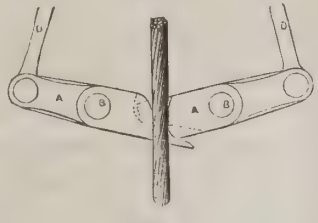


Fig. 3.

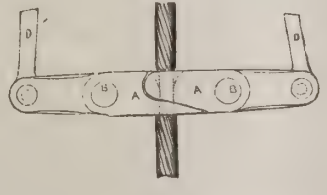


Fig. 4.

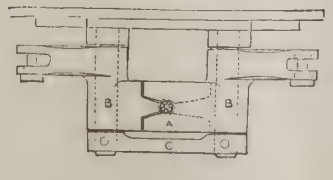
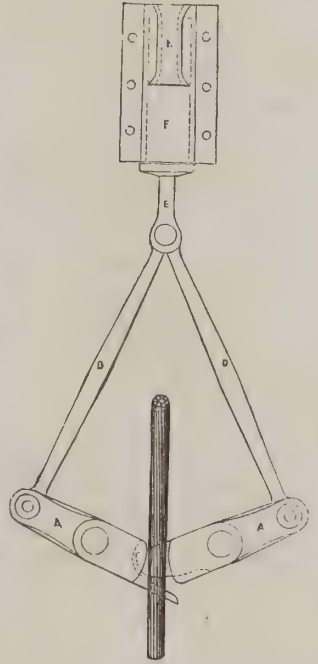


Fig. 5.



is (of its own accord) to bring the cage to an immediate stand by means of catches or compressors which fasten on, encircle, and compress *not only the sides*, but the *whole circumference* of the conductor. When the winding-rope is re-adjusted by the tension of the rope, the compressors spontaneously release their grasp of the conductors, and the whole is again in working order.

The general features of the cage will be readily seen by referring to fig. 1. As the catches, or more properly the compressors, are of very peculiar shape, I have wooden models to show their general construction, [a model was handed round for inspection] and also detailed drawings of them (figs. 2, 3, and 4), showing their positions when out of play, and held from the guides by the tension of the rope, the position they assume when first brought into play, and the iron-wire guide in extreme compression. This will, of course, vary in proportion to the weight on the cage at the time they are brought into requisition. I have chosen two forms of cages to show that the apparatus can be applied successfully to cages of any description, and carrying any weight.

Both cages, although varying slightly in detail, are precisely similar in principle (for this reason a drawing of No. 2 model, fig. 1, only is annexed). On the small cage, model No. 1, the apparatus is attached to the sides of the cage, and is brought to bear simultaneously on both conductors.

On the large rectangular cage, fig. 1, though conducted by four guides, the apparatus is brought to bear on two only, that is, across the corners. The compressors, which are made of malleable iron and case-hardened (lettered A on fig. 5), are of peculiar construction (see detailed drawing, fig. 4) made in plan, in a fork-like shape, and of any proportionate elevational depth. They work on each side of the conductors on axles, B, attached to the cage, and when not in play are held by the tension of the winding rope at an acute angle; and when brought into play, as presently explained, slide into each other, and encircle the conductor, assuming a nearly horizontal position, and forming, both in plan and elevation, a circular hole the full depth of the compressors, but less in diameter than the conductor, so that as the angle is made to increase in proportion to the weight on the cage, so will the compression also increase on the conductors.

The compressors, A, are constructed with lever ends, and when the cage hangs freely on the winding-rope they are held away from the conductors by side rods, D, attached on each side of the cage to main vertical and shouldered rods, E, working through guide boxes, F, in which are inserted spiral springs (merely to give impetus to the compressors) bearing on the inside shoulders of the main vertical rods, E, which are connected on each side of the cage by a cross bar, G, working over the top or cover of the cage, H, and attached to the winding rope. To prevent the compressors, A, wrenching apart, they are connected by a front tie-plate, C. K represents ordinary cast-iron guide boxes through which the conductors slide.

By the above description, and with reference to the figs., it will be seen that when the cage hangs freely on the rope the shoulders on the main vertical rods, E, are brought up by means of the cross bar, G, to the undersides of the guide boxes, F, and the compressors, now being held away from the conductors, are allowed to pass freely between the forks of the catches; but immediately on the rope becoming disconnected from the cross bar, G, the concealed spiral springs, hitherto held in subjection, are released, give impetus to, and assist in bringing the compressors, A, into instantaneous play, which then sliding into one another so close round, and compress the conductor into a circular hole, less in diameter than the conductor itself, through which it is impossible for it to pass, so that the cage is brought to an immediate stand.

In the arrangements by which the compressors are connected to the winding rope it will be perceived that both sets must work simultaneously on the guides, and are such as cannot be easily deranged.

I may add, in conclusion, that the apparatus and arrangements are in course of being patented, provisional protection having been already allowed.

INSTITUTION OF ENGINEERS IN SCOTLAND.

REMARKS ON THE 3RD, 13TH, AND 14TH ARTICLES OF THE ADMIRALTY REGULATIONS FOR PREVENTING COLLISIONS AT SEA.

By JAS. R. NAPIER, F.R.S.

Article 3 relates to the construction and fixing of lights, and the fitting of screens.
Article 13 is the Steering Rule for two Steamers meeting end on, &c.
Article 14 is the Steering Rule for two Steamers crossing, &c.

ONE signing himself T. G. has recently written a pamphlet, the stated object of which is to show, that what he calls "The Rule of the Road for Steamers is Simple, Sufficient, and Intelligible." I ask, if such be its object, for whose instruction it is written, seeing that it is published "*For private circulation only*," and that he has himself proved the contrary by writing his commentary.

That the 13th and 14th Articles should, as he says, "have been fully discussed, considered, and approved by competent naval men, and competent lawyers, belonging to thirty-four countries and states," must be satisfactory to those who framed them. It may perhaps even be accepted as a *proof* that they are simple and intelligible when so many *lawyers* have approved of them; but although I might agree with T. G. that a rule should be considered as simple and intelligible when a lot of stupid fellows understand it, I object to admit that these same stupid fellows are to be considered the best judges of its sufficiency. Or, if lawyers in general, and competent lawyers in particular, are to be considered as having clearer understandings than sailors, for the latter of whom alone the regulations must have been written, I may ask, how the approval of the lawyers affects the objects he has undertaken to show. The insinuation, that because so many have approved of the articles therefore they must be right, is rather impertinent. The fact of a lot of sheep following one another over the bulwarks into the sea, does not make the act of any of them right either for themselves or their owners.

T. G. being well known to be one of the secretaries of the Board of Trade, the probability is that it is published by their authority, and for some other object, one which I shall probably be considered as fulfilling perhaps rudely in the few remarks now offered.

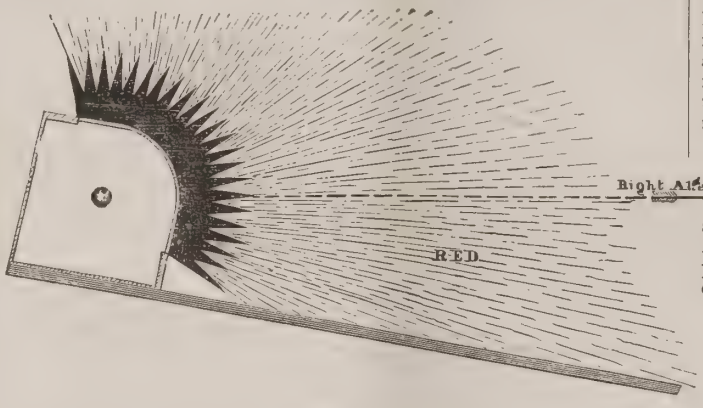
At the opening meeting of this Institution, in October, 1863, I referred to some of the circumstances which cause collisions at sea, viz.:—Ships without any lights whatsoever; the insufficiency of the lights they do carry; and the improper placing of their screens. These circumstances I submit are still unprovided for; they are the cause of much anxiety, and of many accidents which might be prevented.

As it is a fact that many accidents happen, not through misunderstanding or misapplying the 13th and 14th Articles, but by literally obeying them, I submit

that either the regulations themselves are insufficient, or the Board of Trade neglect their duty.

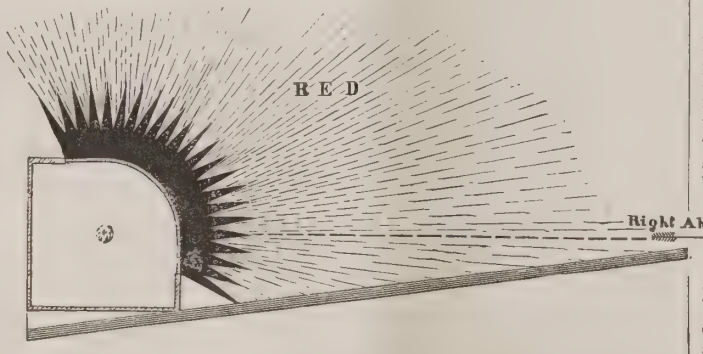
Paragraphs *b* and *c* of the 3rd Article state, that the green and red lights are each to be so fixed as to throw its light from right ahead to two points abaft the beam, and paragraph *d* of the same article, that the green and red lights shall be fitted with inboard screens, projecting at least 3 feet forward from the light so as to prevent these lights being seen across the bow. T. G. evidently believes or

Diagram 1.—Inboard screen illegally fitted, permitting the light to be seen across the bow, instead of preventing it.



knows that these instructions are literally fulfilled in all merchant vessels. The fact, however, is that nearly every merchant vessel's side lights show not from right ahead only, but from half a point to a whole point or more across the bow. The side lights of many are seen from their own fore decks. The screens of many are inclined towards the bow as if for the very object of allowing the light to show

Diagram 2.—Inboard screen legally fitted, preventing as much as possible the light being seen across the bow.



across it; and of all, all now on the Clyde at least, they approach no nearer to the position evidently intended by the 3rd Article than to be placed at the side of the lantern, and parallel to the centre line of ship; and whatever importance may be attached to the condition that the lights are to show *two* points abaft the beam, lights are constructed which show *three* points abaft the beam.

The competent naval men and competent lawyers who approved of the 13th and 14th Articles, must, if they did not also discuss, consider, and approve of the 3rd Article, have at least assumed the fulfilment of its conditions. They must have had the *same* idea of the meaning and application of the terms right ahead and across the bow. In fact, they must have assumed it to be quite practicable so to fit a screen projecting at least 3 feet from the light, that the light would show right ahead and be prevented from showing across the bow. If they were justified in so doing, and if, as is undoubtedly the case, it is only when the conditions of this 3rd Article are as nearly as possible fulfilled (for literally they cannot be with any lights hitherto constructed for ships' use), that the 13th and 14th can in any sense be called sufficient.

It is clear that the Board of Trade, in permitting vessels to go to sea with their lights constructed, fixed, and screened as they are, and not as the 3rd Article requires, neglect their duty; and it is not difficult to show that they thereby render the 13th and 14th Articles not only insufficient, but absolutely dangerous. They ignore the necessity of that condition being fulfilled, or even approximated to, on which alone the "Rule of the Road," as it is called, is founded, and without which there is either no rule at all or a wrong one.

Although Mr. Thomas Gray, whom I take to be the author of the pamphlet signed "T. G.," has recently put the rule he has been commenting on, and other rules, into verse, as aids to the memory, I submit that at present they are deceitful and dangerous, and ought to be suppressed until the screens are altered; and that the following lines, suggested by a communication from *Punch* on 23rd November, should be authorized, as they represent the effect of the present practice of fixing and screening lights, and are much more likely to prevent collisions than Mr. Gray's verses:—

WEATHER DARK AND CLOUDY.

A., seeing Three lights nearly ahead on Starboard side, Sings, to aid his memory:—

A meeting steamer I'll not dread,
When I see three lights ahead;
I'll port my helm and show my red,
And if I'm smashed what can be said.

B., seeing a White and Green light nearly ahead on Starboard side, Sings, to aid his memory:—

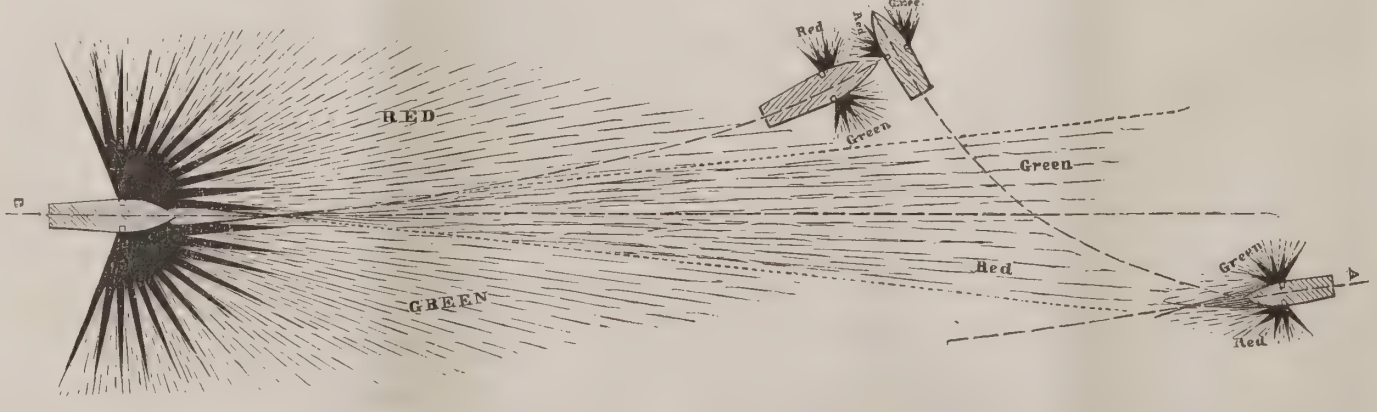
Green to Green, so it's said,
Is perfect safety—Go ahead.
But if the Lubber port, I say
A collision's likely, Thomas Gray.

Professor Rankine said it was quite evident that there was great difficulty in placing a light so that it should be seen from all points right ahead, and not seen across the bows. If they were to proceed on a system that was adopted in some lighthouses by Mr. Stevenson, and construct a lantern with a combination of reflectors and other optical apparatus, so as to concentrate the whole light of the flame into an angular space from a line right a-head to two points abaft the beam, there would be a dark space of a breadth equal to the distance between the port and starboard lights. In order that such dark space might not exist, the lights must be allowed to be partially seen across the bows. There was thus a practical difficulty. It would be very interesting if some of the shipbuilders present, or others connected with shipping, would give their attention to this matter. Did Mr. Napier consider the dark space between the lights a practical evil?

Mr Napier stated, in reference to Professor Rankine's remark, that he thought the dark space between side lights constructed to show right ahead, and not across the bow, was not a serious objection. It was vastly less objectionable to have this space dark than to have it lighted across the bow. Vessels never kept on a straight line for any time; the slightest deviation of the approaching vessel would bring one of the side lights into view, and the look-out had only to walk across his own vessel's deck to see what lights were visible from that position. Moreover, putting the side lights closer, into one lantern if necessary, would remove all the dark band. Sailors had not yet learned the value of this delicate adjustment of their lights, and were apparently not aware of the danger arising from the present system.

Mr. Curle perfectly agreed with Mr. Napier, that a great number of the lights

Diagram 3.—"Green to green, or red to red, Perfect safety—Go ahead!"—T. G.



of vessels were not properly attended to in placing them. But that would always be the case until some one was appointed to inspect them. The steamers were inspected twice a-year, and they should be right placed; but he did not know that the sailing vessels were inspected, and many of them were very bad. He believed that if any one went over the harbour he would find them to vary less or more, and not one of them perfectly correct. He had seen some of them placed within 20 or 30 feet of the stern, so that the round of the ship would do away with that which Mr. Napier had been making objection to.

Mr. Alexander Smith suggested that Mr. Napier should make a diagram to illustrate and go along with his paper.

Mr. Napier said he would be glad to do so.

Note by Mr. Jas. R. Napier.—Received 2nd December, 1867.

The diagrams illustrate what has been stated in the paper. Diagram 1 shows a common arrangement in screw steamers—a screen placed inclined towards the bow of the ship, permitting the light to be thrown a long way across the bow (of the regulations).

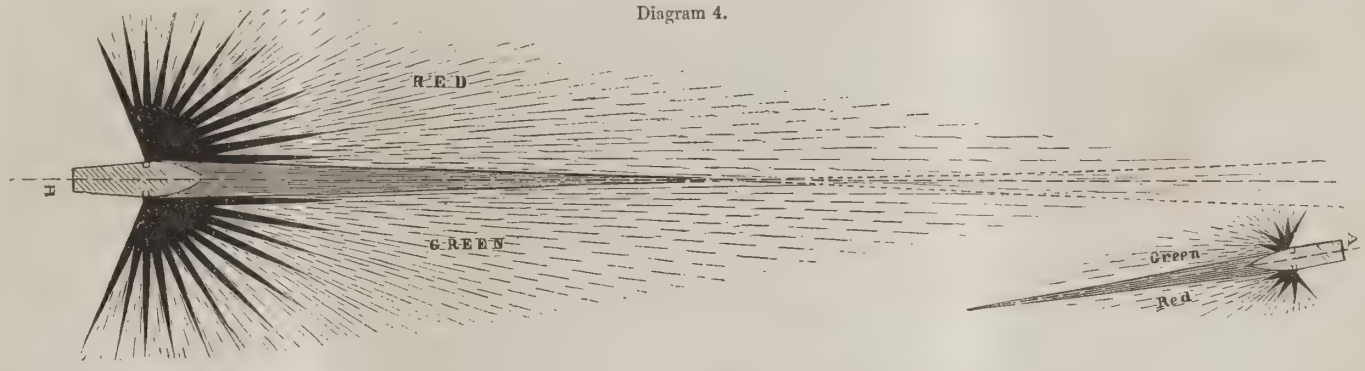
Diagram 2 shows a screen placed so as to allow the light to be seen from right ahead (of the light), and as little as possible across the bow.

A plane passing through the outboard forward edge of the screen and the inboard side of the light, is intended to be parallel with the longitudinal vertical plane passing through the centre of the ship.

Diagram 4 shows the dark band between lights screened as in diagram 2.

The effect of applying the 13th and 14th Articles of the Regulations to lights fitted with screens which permit the light to be seen across the bow may be more easily understood from diagram 3, which, so far as the positions of the vessels are concerned, is intended to be an enlarged copy of one of Mr. Gray's diagrams:—A., seeing a White, Red, and Green light nearly a-head on his starboard side, knows that a steamer is approaching. A. may believe that B. is coming right down on him, and if the lights did not show across the bow, this would be actually B.'s course. But as B.'s lights show across the bow, B. may be going either the course

Diagram 4.



shown on the diagram, a direct course for A., or crossing A.'s bow. In any of these cases, whether B. is viewed as a meeting or a crossing steamer, it appears that A. is to keep clear of B. This A. tries to do by "porting," as shown on the diagram, and by so doing runs directly into danger. B., on the other hand, seeing A's White and Green lights only, nearly ahead on starboard side, knows that A. is passing clear of him. B., therefore, according to Mr. Gray's reading of the Regulation, either keeps his course, or gives A. a wider berth by "starboarding," as in the diagram. If A.'s Red light now becomes visible to B., it may come too late to prevent a collision.

We shall probably comment upon the valuable suggestions contained in this paper next month.

INSTITUTION OF CIVIL ENGINEERS.

Subjects for Premiums, Session 1867–68.

The Council of the Institution of Civil Engineers invite communications on the Subjects comprised in the following list, as well as upon others; such as, 1. Authentic Details of the Progress of any Work in Civil Engineering, as far as absolutely executed (Smeaton's Account of the Eddystone Lighthouse may be taken as an example); 2. Descriptions of Engines and Machines of various kinds; or 3. Practical Essays on Subjects connected with Engineering, as, for instance, Metallurgy. For approved Original Communications, the Council will be prepared to award the Premiums arising out of special funds devoted for the purpose.

The Council will be glad to receive, for the purpose of forming an "Appendix" to the Minutes of Proceedings, the details and results of any experiments or observations, on subjects connected with Engineering Science or Practice.

1. On the Theory and details of Construction of Metal and Timber Arches.
2. On Land-slips, with the best means of preventing or arresting them, with examples.
3. On the Principles to be observed in Laying-out lines of Railway through mountainous countries, with examples of their application in the Alps, the Pyrenees, the Indian Ghâts, the Rocky Mountains of America, and similar cases.
4. On Railway Ferries, or the Transmission of Railway Trains entire across Rivers, Estuaries, &c.
5. On the Pneumatic System for the conveyance of Passengers and Goods.
6. On the Systems of fixed Signals at Present in use on Railways.
7. On the most suitable Materials for, and the best mode of formation of, the Surfaces of the streets of large Towns.
8. On the Construction of Catch-water Reservoirs in Mountain Districts, for the supply of Towns, or for Irrigation, or Manufacturing purposes.
9. Accounts of existing Water-works; including the source of supply, a description of the different modes of collecting and filtering, the distribution throughout the Streets of Towns, and the general practical results.
10. On the Benefits and Expedients of Irrigation in India and in other warm climates; and on the proper Construction of Irrigating Canals, so as to avoid erosion or silting, and to prevent the growth of weeds.
11. On the best mode of Deodorizing and Filtering, or otherwise of precipitating Sewage, and of applying it to the land.
12. On the Ventilation of Sewers.
13. On the Ventilation and Warming of Public Buildings.
14. On the best means of Manufacturing Gas of high Illuminating Power; and on the Construction of Gas Works, the most economical system of distribution of Gas, and the best modes of Illumination in Streets and Buildings.
15. A History of any Fresh Water Channel, Tidal River, or Estuary—accompanied by plans and longitudinal and cross sections of the same, at various periods, showing the alterations in its condition—including notices of any works which may have been executed upon it, and of the effects of the works; particularly of the relative value of Tidal and Fresh Water, of the effect of Inclosures from the Tidal Area upon the general regime, of Sluicing where applied to the improvement of the entrance or the removal of a Bar, and of Groynes, or Parallel Training Walls. Also, of Dredging, with a description of the Machinery employed, and the cost of raising and depositing the material.
16. On the Construction of Tidal, or other Dams, in a constant or variable depth of water; and on the use of wrought iron in their construction.
17. On the Arrangement and Construction of Floating Landing-Stages for passenger and other traffic, with existing examples.
18. On the different systems of Swing, Lifting, and other opening Bridges, with existing examples.
19. On the Construction of Lighthouses, their Machinery and Lighting Apparatus; with notices of the methods in use for distinguishing the different Lights.
20. On the Measure of Resistance to Bodies passing through Water at high Velocities.
21. On Ships of War, with regard to their Armour, Ordnance, mode of Propulsion, and Machinery.
22. On the measures to be adopted for Protecting Iron Ships from Corrosion.
23. On the Construction and Performance of Turbines of all classes.
24. On the comparative cost of Conveying Coals by Railways and by Screw Colliers.
25. On the present systems of Smelting Iron Ores; or the conversion of cast iron into the malleable state, and of the manufacture of iron generally, comprising the distribution and management of Iron Works.
26. On the Manufacture of Iron for Rails and Wheel Tires, having special reference to the increased capability of resisting lamination and abrasion; and accounts of the Machinery required for rolling heavy Rails, Shafts, and bars of Iron of large sectional area.
27. On the Bessemer and other processes of Steel-making; on the present state of the Steel Manufacture on the Continent of Europe; and on the employment of castings in Steel for Railway Wheels and other objects.
28. On the Use of Steel for the Tires and Cranked Axles of Locomotive Engines, especially with reference to its durability and the cost of repairs, as compared with Iron of acknowledged good quality; and on the use of Steel Bars and Plates generally in Engine-work and Machinery, for Boilers and for Shipbuilding, as well as for Bridges.
29. On the safe working strength of Iron and Steel, including the results of experiments on the Elastic Limit of long bars of Iron, and on the rate of decay by rusting, &c., and under prolonged strains.
30. On the present state of Submarine Telegraphy, and on the transmission of Electrical Signals through Submarine Cables.
31. On the present relative position of English and Continental Engineering Manufactories, especially with reference to their comparative positions in respect of the cost, and the character of the work produced.

The Council will not consider themselves bound to award any Premium, should the Communication not be of adequate merit, but they will award more than one Premium, should there be several communications on the same subject deserving this mark of distinction. It is to be understood that, in awarding the Premiums, no distinction is made, whether the communication has been received from a Member or an Associate of the Institution, or from any other person, whether a native or a foreigner.

The Communications must be forwarded, on or before the 1st of February, 1868, to the house of the Institution, No. 25 Great George Street, Westminster, S.W., where copies of this paper, and any further information, may be obtained.

CHARLES MANBY, *Honorary Secretary.*
JAMES FORREST, *Secretary.*

EXTRACT FROM THE MINUTES OF COUNCIL, FEBRUARY 23, 1835.

The principal subjects for which Premiums will be given are:—

1st. Descriptions, accompanied by Plans and explanatory Drawings, of any work in Civil Engineering, as far as absolutely executed; and which shall contain authentic details of the progress of the Work (Smeaton's Account of the Eddystone Lighthouse may be taken as an example).

2ndly. Models or Drawings, with descriptions of useful Engines and Machines; Plans of Harbours, Bridges, Roads, Rivers, Canals, Mines, etc.; Surveys and Sections of Districts of Country.

3rdly. Practical Essays on subjects connected with Civil Engineering, such as Geology, Mineralogy, Chemistry, Physics, Mechanic Arts, Statistics, Agriculture, etc.; together with Models, Drawings, or Descriptions of any new and useful Apparatus or Instruments applicable to the purposes of Engineering or Surveying.

EXCERPT BYE LAWS, SECTION XV., CLAUSE 3.

"Every Paper, Map, Plan, Drawing, or Model, presented to the Institution, shall be considered the property thereof, unless there shall have been some previous arrangement to the contrary, and the Council may publish the same in any way and at any time they may think proper. But should the Council refuse or delay the publication of such Paper beyond a reasonable time, the author thereof shall have a right to copy the same, and to publish it as he may think fit, having previously given notice, in writing, to the Secretary of his intention. No person shall publish, or give his consent for the publication of any communication presented and belonging to the Institution, without the previous consent of the Council."

INSTRUCTIONS FOR PREPARING COMMUNICATIONS.

The Communications should be written in the impersonal pronoun, and be legibly transcribed on foolscap paper, about thirteen inches by eight inches, the lines being three-quarters of an inch apart, on the one side only, leaving a margin of one inch and a half in width on the left side, in order that the sheets may be bound.

The Drawings should be on mounted paper, and with as many details as may be necessary to illustrate the subject. Enlarged Diagrams, to such a scale that they may be clearly visible, when suspended on the walls of the theatre of the Institution, at the time of reading the communication, should be sent for the illustration of any particular portions.

Papers which have been read at the Meetings of other Scientific Societies, or have been published in any form, cannot be read at a Meeting of the Institution, nor be admitted to competition for the Premiums.

MONTHLY NOTES.

MONTHLY PROGRESS OF MONT CENIS TUNNEL.—According to the usual monthly statement of the progress made in the Mont Cenis Tunnel, published by the Italian Government, the length of boring during the month of October was 131·85 metres, of which 71·20 metres were on the Italian side at Bardonneche, and 60·65 metres at Modane, on the French. The position of the tunnel up to the 31st October is as follows:—

	Metres.
Total length of tunnel,	12,220·00
" boring,	7,664·10
Remaining to be done,	4,555·90

During the first ten months of the present year the progress made in the tunnel has been 1329·56 metres, whilst on the other hand, during the whole of last year, the progress made was only 1024·99 metres. The boring at the southern end advances more rapidly than at the north. Up to the 31st October, the progress made at the south was 4640·10 metres, whilst at the north end only 3024 metres have been bored. From the steady progress made every month, it may safely be predicted that in 1870 this great work will be completed.

STATISTICS OF CALIFORNIA.—California contains 98,634,240 acres of land, of which 65,000,000 are adapted to agriculture, and 15,000,000 additional to grazing purposes. Of the agricultural land about 1,504,680 acres were under cultivation in 1856. In that year 481,472 acres of land yielded 11,579,127 bushels of wheat; 558,916 acres yielded 15,462,783 bushels of barley; 77,776 acres yielded 2,078,627 bushels of oats. The average yield throughout the state, per acre, was a little over 24 bushels of wheat, nearly 27½ bushels of barley, and 26½ bushels of oats. In 1865, 1,433,933 gallons of wine and 101,150 gallons of brandy were produced. Last year the wine produced was estimated at 2,100,000 gallons. The state contains 148 flour mills, sixty-two of which are driven by steam, and the remainder by water. These mills can produce 13,850 barrels of flour per day. The two paper mills turned out paper last year of the value of 172,801 dollars. The powder works produced 80,000 kegs of blasting and 5000 kegs of sporting powder. More than 4,000,000 dollars' worth of sugar were refined during the year. The value of cigars manufactured in San Francisco during the year 1866 amounted to over 1,000,000 dollars, while the value of the tobacco manufactured in other forms was only 66,000 dollars. The confectioners of San Francisco made 300,000 dollars' worth of confectionery. Of soap, there was manufactured 361,590,600 pounds, worth 300,000 dollars. The San Francisco breweries produced 2,500,000 gallons of beer and ale.

NEW ACT ON EQUITABLE COUNCILS.—With the view of adjusting differences between masters and workmen, an Act has recently passed the legislature. The mode of proceeding under this Act is for a number of masters and workmen in a locality to call a meeting, and agree to form a council of conciliation and arbitration, and to petition the Crown or the secretary of state for the Home Department to grant a license, which may be done after notice in the newspapers. A council is to consist of not less than two nor more than ten masters and workmen and a chairman, and the petitioners for a license are to proceed to the appointment of a council from among themselves within thirty days after the grant of license. The council will remain in office until the appointment of a new council in its stead. The council is to have power to determine questions submitted to it, and its awards are to be enforced in the manner prescribed by the Act 5th Geo. IV. c. 96, by an application to a magistrate, by distress, sale, or imprisonment. No council is to establish a rate of wages or price of labour or workmanship at which the workman shall in future be paid. A committee of conciliation is to be appointed by a council. No counsel, solicitors, or attorneys are to be allowed to attend any hearing before the council or committee of conciliation unless by the consent of both parties. Householders and part-occupiers may demand to be registered and to have a vote for the council, and may be elected thereto. A registry is to be kept, and the masters and the workmen are to elect the council.

BRONZE COLOURS.—The processes of making these colours begin with preparing the proper alloy, either of copper and zinc or copper and tin, in due proportions. These alloys are cast in plates and hammered out into sheets by steam hammers. After they have been brought to the thickness of a stout sheet of paper, these sheets, with frequent intervening annealings, go through a system of rollers, from whence they go to the acid-room, where diluted acid and washing with water removes the scale and stains. The cutting of the sheets into shreds is the next operation, after which the shreds of fine sheet metal are well mixed with dextrine, to avoid the dust of the next stage of manufacture. Powerful quartz-crushers then soon reduce the metal to coarse powder, ready to go to the grinding and polishing mills, which consist of tempered wavy steel plates, over which steel rods travel at a great speed, grinding and polishing the bronze at the same time, and the quality or grain of the article is determined by the length of time to which it is subjected to the operation of these mills. Washing and straining the bronze powder, to get rid of accidental impurities of the dextrine, are the next steps, after which the bronze is put into bags of fine but strong cloth and exposed to the pressure of a hydraulic press, to squeeze the water out and lessen its bulk. Drying at a low temperature and packing into pound or ounce packages makes the article ready for the market.—*American Artisan.*

THE AIR IN RAILWAY TUNNELS.—The following report of an examination of the air in the tunnels of the Metropolitan Railway was read at the inquest upon the body of Elizabeth Stainsby, whose death was alleged to have been caused or accelerated through the foulness of the air in the tunnels of the underground railway. The evidence had shown that the deceased was suffering from disease of the heart at the time of her death:—

LONDON, *October* 23, 1867.

Having received instructions from the directors of the Metropolitan Railway Company, through Messrs. Burchell, their solicitors, by letter addressed to Dr. Bachhoffner, to examine and report on the state of the atmosphere in the different tunnels on their line, and on the sanitary condition generally of the stations and tunnels, we beg to present the following as the result of our investigations:—

We proceeded in the first instance to obtain samples of the air in the tunnels, and we collected them on three separate occasions, namely, first, immediately after the trains had ceased running at night; secondly, just before they commenced running in the morning; and, thirdly, in the afternoon between four and five o'clock, the period of the day when there is generally the greatest amount of traffic.

The samples, twenty-eight in number, were taken at different places in each tunnel, and at different altitudes; some near the crown of the arch, some near the ground, and others on a level with the heads of the passengers. These samples were analyzed for sulphurous acid, carbonic acid, carbonic oxide, coal gas, and oxygen.

The presence of sulphurous acid was sought for by the most delicate chemical test with which we are acquainted, namely, its action upon iodic acid and starch, which we have ascertained is capable of showing the presence of one part by volume of sulphurous acid in 100,000 parts of air; but we could not in any case discover by such test the presence of this acid, from which we conclude that its volume was less than the above in the tunnels. The proportion of carbonic acid by volume in 10,000 parts of the air in the several tunnels and stations was as follows:—

Tunnel.	Max.	Min.	Mean.
Tunnel between Bishop's Road and Edgware Road, 2 a.m., 3rd September,	4·1	4·1	4·1
Tunnel between Edgware Road and Baker Street, 1 to 3 a.m., 3rd September,	5·2	4·3	4·8
Tunnel between Edgware Road and Baker Street, 2 to 4 a.m, 6th September,	5·4	4·7	5·0
Tunnel between Edgware Road and Baker Street, 4 p.m., 7th September,	—	—	5·7
Baker Street Station, 4 p.m., 10th September,	—	—	6·2
Tunnel between Baker Street and Portland Road, 1 to 3 a.m., 3rd September,	6·0	4·6	5·1
Tunnel between Baker Street and Portland Road, 2 to 4 a.m., 6th September,	4·5	4·2	4·4
Tunnel between Baker Street and Portland Road, 4 p.m., 7th September,	—	—	6·9
Tunnel between Portland Road and Gower Street, 1 to 3 a.m., 3rd September,	6·0	5·1	5·5
Tunnel between Portland Road and Gower Street, 2 to 4 a.m., 6th September,	6·1	4·5	5·1
Tunnel between Portland Road and Gower Street, 4 p.m., 7th September,	—	—	12·7
Gower Street Station, 4 p.m., 7th September,	—	—	5·7
Tunnel between Gower Street and King's Cross, 1 to 3 a.m., 3rd September,	5·4	4·4	4·9
Tunnel between Gower Street and King's Cross, 2 to 4 a.m., 6th September,	5·2	4·3	4·6
Tunnel between Gower Street and King's Cross, 4 p.m., 7th September,	—	—	9·1

The amounts of carbo-hydrogen (coal gas) and of carbonic oxide present were so small as to be barely discoverable by the most delicate processes of analysis. Lastly, we ascertained that the amount of oxygen in the air of the tunnels and stations was not in any case deficient.

These results prove that in no instance was the air found to be vitiated to any material extent, although it will be seen that the air taken in the afternoon was less pure than that taken at night. The researches of Regnault, Bunsen, and other eminent chemists, and more recently those of Dr. Angus Smith, show that what may be termed 'model or normal atmospheric air' in cities and large towns consists in every 10,000 parts by volume of—

Oxygen,	2,096
Nitrogen,	7,900
Carbonic acid,	4
	10,000

It is the last constituent which when in excess renders the air impure, and in proportion to its increase, so is the air made unfit for respiration. Experiments conducted by Dr. Bernays and Dr. Angus Smith have shown that in several of our London theatres at about ten o'clock p.m., in many other places of public resort, and especially in some of our law courts, the quantity of carbonic acid in the atmosphere of those places varied from 10 to 32 parts per 10,000; and from the 'Army Report,' vol. v., page 272, it appears that in some fairly-ventilated barracks at Aldershot the quantity of carbonic acid at midnight amounted to 6·42 per 10,000 of air, and at five p.m. it amounted to 7·59 per 10,000; and in the Wellington Barracks from 11·9 to 14·2 per 10,000. Even in the streets of Manchester, in foggy weather, it has amounted to 8 parts per 10,000 of air.*

In order to determine the atmospheric conditions of these tunnels by comparison with the condition of the air in the tunnels of other lines of railway, we took samples of the air from several tunnels near London, and from these, which we designate by numbers only, we obtained the subjoined results:—

	Carbonic acid per 10,000 of Air by volume.
Tunnel No. 1,	4·7
" 2,	12·1
" 3,	4·6
" 4,	4·3
" 5,	7·8
" 6,	4·5
" 7,	5·3
" 8,	4·3
" 9,	4·2
" 10,	5·1
" 11,	4·3
" 12,	4·2
" 13,	4·6

Our next inquiries were directed to the quality and quantity of the fuel used in the engines, and to the mode by which its combustion is effected. The plan adopted (with which we cordially agree) is to diminish as far as practicable the combustion of the fuel during the passage of the trains through the tunnels and stations. The steam in the boiler is raised in the open air to a temperature and pressure which, by experience and daily practice, is found sufficient to work the trains through the tunnels; and when the trains come again into open space, fresh steam is then generated sufficient to propel the trains through the next journey, when the process is again repeated; by which means the engine-driver is enabled, when passing through the tunnels and stations, to close the fire-box and damper, so as merely to keep the fire in such a condition that it may be easily revived at either end of the journey.

The evolution of the products of combustion is thus almost entirely confined to that portion of the journey when the trains are passing through the open spaces.

The coke is of a superior quality, being made from a coal which is known to be more than usually free from iron pyrites, and it is burnt in the ovens for twenty-four hours longer than the ordinary coke generally used upon railways. In addition to which a staff of eight men and a foreman are constantly employed in examining and selecting the coke, so as to insure that none but the best quality of coke is transmitted to London for the use of the Underground Railway.

To determine the percentage of sulphur in the coke, thirteen samples were submitted to chemical analysis, and these gave an average proportion of 0·26 per cent. of sulphur, which is about one-fourth the quantity found in ordinary coke. As regards the coke, therefore, we see nothing to which we can take exception, but, on the contrary, we are of opinion that the best available means are used for obtaining a fuel as free from deleterious matter as possible, in addition to which the combustion of the same is conducted with the view of preventing as far as possible the escape of offensive gases.

The presence of sulphur, or, more correctly speaking, of sulphurous acid gas, in the tunnels and stations, which at times is appreciable both to taste and smell, more particularly on those days when the external atmosphere is unusually dense, must not be taken as an indication that this gas exists in dangerous quantities, for as little as one part of this gas in 100,000 parts of atmospheric air is strongly perceptible both to taste and smell; and paper moistened with a solution of iodic acid and starch becomes tinged with a blue colour when exposed for a few minutes to air having the above proportion of sulphurous acid. On several occasions we have exposed this delicate test to the air in the tunnels while passing through them, both in the carriages and on the engines; and although the quantity of air thus brought into contact with the test has been considerable, yet it has only been during the time of active traffic that the test has shown the presence of sulphurous acid, and then in an insignificant degree. In addition to the above, we beg to point out another cause which communicates to the air, more particularly in the stations, a pungent smell, which, although disagreeable, cannot in the slightest degree be regarded as injurious to health; we allude to the partial combustion of the wood forming the breaks when acting upon the tires of the wheels in checking the speed of the train as it approaches the stations.

The number of trips made by the trains through the tunnels daily amounts to 358, of which 284 are by the narrow-gauge trains, and seventy-four by the broad-gauge. Each of the narrow-gauge trains occupies 20,000 cubic feet of space, and those of the broad-gauge 23,000 cubic feet. The length of time occupied by each train in passing through the tunnels and stations is ten minutes. There are numerous openings communicating with the external atmosphere above, amounting in the aggregate to 3164 square feet, and distributed in the following manner: namely, Baker Street Station, 1362 square feet; Portland Road Station, 863 square feet; Gower Street Station, 939 square feet. The western end of the tunnel at Edgeware Road opens into a large area called the Yard, and at the eastern end of the tunnel at King's Cross an opening has been made directly into the atmosphere, 40 feet in width, in addition. By an extensive series of thermometric observations we find that there is an average difference of about 1°·7 Fahrenheit between the temperature of the tunnels and that of the external atmosphere; the mean outside temperature being 70° Fahrenheit, while the air in the tunnels had a mean temperature of 68°·3 Fahrenheit, so that it was 1°·7 Fahrenheit colder than the external atmosphere. During the winter months this condition will possibly be reversed; but in either case there will be a rapid change of air by an ascending and descending current. Having regard to the cubical volume of the trains, the short time occupied by them in passing through the tunnels and stations, the large volume of air which they displace, and the increased impetus given to the horizontal movement of the air by the rapidity of the transit, we are of opinion that the vitiation of the atmosphere cannot be of a serious character, and this accords with the results of our analysis.

A careful inspection of the tunnels has also shown that they are well constructed, and are generally dry and free from infiltration of liquid or other matter prejudicial to health, with the exception of a portion of the tunnel between Portland Road and Gower Street; to this we directed the attention of Mr. Fenton immediately after our inspection; and we are happy to be able to add that the defect was at once attended to, and is now in a perfect sanitary condition.

We find on inquiry that the general health of the *employés* is such as to afford unquestionable proof of the sanitary condition of the air in the tunnels. From a statement furnished to us by Mr. Fenton, it appears that the percentage of sickness and mortality of these persons is considerably less than that of the *employés* on the Great Western Railway. To this fact we may add the results of our own personal inquiries, which fully confirm it, as many of the engine-drivers and guards have, we find, been in the service of the company since the opening of the line. They are, to all external appearance, robust, healthy men, and they have assured us that since they were first appointed they have scarcely had a day's illness.

From the foregoing facts, we are enabled confidently to state that the atmosphere of the Metropolitan Railway is not unwholesome or injurious to health.

(Signed)

Geo. H. Bachhoffner, Ph.D., F.C.S., &c.
Hy. Letheby, M.B., M.A., &c., Professor of Chemistry in the College of the London Hospital, and Medical Officer of Health for the City of London.
J. Whitmore, M.D., &c., Medical Officer of Health, and Chemical Examiner of Gas for the Parish of St. Marylebone.

It may be mentioned that the jury, without hesitation, found a verdict of 'Died from natural causes.'

* AMOUNTS OF CARBONIC ACID PER 10,000 OF AIR IN DIFFERENT PLACES.

	Min.		Max.		Mean.
1. *Cities and Towns:*—					
London,	2·8	...	4·3	...	3·4
Manchester,	4·9	...	15·0	...	5·4
Munich,	—	...	—	...	5·0
Madrid,	3·0	...	8·0	...	5·2
Paris,	3·6	..	5·1	...	4·9
2. *Places of Public Resort:*—					
Court of Chancery (doors closed),	—	...	—	...	19·8
" " (doors open),	—	...	—	...	4·8
Chamber of Deputies, Paris,	—	...	—	...	25·0
Theatres (London),	7·6	...	32·0	...	14·9
" (Manchester),	10·2	...	27·3	...	14.8
" (Paris),	23·0	...	43·0	...	33.0
3. *Dwelling-houses by day,*	5·4	...	12·7	...	7·8
4. *Dwelling-houses by night:*—					
In a study near table,	—	...	—	...	11·8
" near ceiling,	—	...	—	...	15·6
Bedroom at night,	—	...	—	...	28·0
" window open,	—	...	—	...	8·0
5 *Dormitories:*—					
At Saltpetrière,	—	...	—	...	80·0
Another at ditto,	—	...	—	...	58·0
Workhouse ward,	—	...	—	...	125·0
Lodging-house in City,	—	...	—	...	100·0
6. *Schools by day:*—					
Various in France,	27·0	...	47·0	...	36·0
" in Germany,	20·0	...	56·0	...	39·2
" in England,	9·7	...	31·0	...	21·5
7. *Mills and Workshops,*	28·3	...	30·0	...	29·1
8. *Barracks at night,*	11·9	...	14·2	...	12·8
9. *Cornish Mines:*—					
Good,	—	...	—	...	8·0
Bad,	—	...	—	...	190·9
10. *In expired Breath,*	350 0	...	500·0	...	452·0
11. *In room with chafing-dish,*	—	...	—	...	1 400·0

APPLICATIONS FOR

PROVISIONAL PROTECTION FOR INVENTIONS

UNDER THE PATENT LAW AMENDMENT ACT.

☞ When the city or town is not mentioned, London is to be understood.

19th November, 1867.

3273 R. Ward, Manchester, and T. Travis, Royton—Woven fabrics
3274 E. Reynolds, Sheffield—Wheels for railway carriages
3275 W. J. Coleman, Edmonds, and A. Coleman, Lombard Street—Treating food
3276 H. English and J. Farndon—Shuttles of looms
3277 W. Anderson, Erith—Evaporating apparatus
3278 R. A. E. Scott, Hornsey Lane—Mounting and working ordnance
3279 A. Barclay, Kilmarnock—Motive-power engines
3280 E. T. Trenery, Gainsborough—Traction engines

20th November, 1867.

3281 C. Mole, Farringdon Road—Soles and heels for boots and shoes
3282 W. H. Richardson, Glasgow—Iron and steel
3283 S. Coulson, Sheffield—Coffins
3284 H. H. Lloyd, Douglas—Railway carriage
3285 T. H. Tilley, Cheapside—Couplings for boring tools
3286 J. Oppenheimer, Manchester—Telegraph posts
3287 H. Green, King William Street—Safety lamps
3288 C. de Lavenant, Brixton Road—Coating metals
3289 J. Staincliffe, Lane Ends—Smoke-consuming apparatus
3290 W. Brewster, Redditch—Washing clothes
3291 L. R. Joseph, Wyattville—Tramways for common roads

21st November, 1867.

3292 J. Owens, Salford—Pile and other fabrics
3293 W. R. Lake, Chancery Lane—Packing
3294 G. F. Redfern—Paving.—A com.
3295 J. Townsend, Glasgow—Soda and potash
3296 C. Butler, Birmingham—Lamps
3297 S. and B. Barczinsky, Northfleet—Illusory exhibitions.—A com.
3298 J. F. Watson, Clerkenwell—Watches
3299 W. R. Green, Peckham, and J. G. Freeman, Newington—Motive power
3300 W. Blundell, Maddox Street—Cowls
3301 W. J. Murphy, Cork—Fire-arms
3302 W. J. M'Ivor, Anfield—Apparatus for rendering innocuous the momentum of heavy bodies
3303 E. Thorold, Lee—Lamps
3304 E. W. Hughes, Westminster—Rotary engines and pumps
3305 H. James and E. Drewett—Water-closets

22nd November, 1867.

3306 R. Leighton, Shoe Lane, and T. Kirkham, West Brompton—Sewing sheets of paper
3307 V. Burchell, Kingstown—Soda water
3308 J. Wormald, Roundell Street, and W. B. Dalton, Windmill Street—Fire-arms
3309 J. G. Tongue, Chancery Lane—Gibs.—A com.
3310 T. G. F. Dolby, Old Town—Hot-water food warmer
3311 Archibald Munro, Arbroath—Boring or cutting rocks
3312 G. Welch, Dundee—Killing whales
3313 J. H. Brown, Strand—A new game to be played with balls

23rd November, 1867.

3314 G. D. Hughes, Nottingham—Economizing fuel
3315 W. Needham and J. Kite, Vauxhall—Depurating
3316 G. H Bolton, W. Whitthread, and E. Bolton, Widnes, and T. Robinson, St Helens—Motive power
3317 E. T. Hughes, Chancery Lane—Telegraphic apparatus.—A com.
3318 P. Salmon, Westminster—Gas
3319 W. Boulton, Burslem—Transmitting motive power to potters' wheels
3320 W. Macnab, Greenock—Marine steam engines
3321 C. E. Brooman, Fleet Street—Steam generators
3322 S. Amphlet and J. B. Fenby, Birmingham—Ruling ornamental patterns
3323 W. Mort, Fenchurch Street—Preserving meat.—A com.
3324 J. H. Johnson, Lincoln's Inn Fields—Fire-arms.—A com.

25th November, 1867.

3325 M. A. Hamilton, Chancery Lane—Railway rails
3326 T. Barton, Limehousefields—Cribbage board
3327 F. Brown, Luton—Kitchen ranges
3328 G. Turner, Dublin—Packing cases
3329 T. L. Greenwood, Dewsbury—Dyeing piece goods indigo blue
3330 T. J. Mayall, Dalston—Accumulating sheets of paper
3331 G. B. Galloway, Newcastle-upon-Tyne—Ships and other vessels
3332 R. Ward, Newcastle-upon-Tyne—Twisting tobacco
3333 T. Chalmers, New York—Seamless tubes.—A com.
3334 A. V. Newton, Chancery Lane—Steam engine.—A com.
3335 W. F. Stanley, Holborn—A new instrument to be called meteorometer

26th November, 1867.

3336 R. M. Letchford, Bethnal Green—Cigars
3337 W. Sim, Glasgow—Cleansing streets
3338 H. Greenhalgh, Bolton—Mechanism
3339 J. P. Smith, Glasgow—Cutting tools
3340 J. P. Smith, Glasgow—Coating and uniting metals
3341 E. Townsend, Lambeth—Tobacco-pouches
3342 C. E. Penny, West Smithfield—Envelopes
3343 J. A. and J. Hopkinson, Huddersfield—Steam boilers
3344 J. and J. Hinks, Birmingham—Safety cans
3345 W. R. Lake, Chancery Lane—Fire-arms.—A com.
3346 W. R. Lake, Chancery Lane—Telegraph apparatus.—A com.
3347 J. Hudson, Urpeth—Paper
3348 C. T. Higginbotham, Glasgow—Furnaces
3349 J. H. Johnson, Lincoln's Inn Fields—Skins.—A com.
3350 A. V. Newton, Chancery Lane—Steam injector—A com.
3351 A. V. Newton, Chancery Lane—Paper pulp.—A com.
3352 E. H. Bentall, Heybridge—Conversion of iron into blooms
3353 M. A. Hamilton, Chancery Lane—Lamp burners

27th November, 1867.

3354 C. Coates, Sunnyside—Cutting or dressing stone
3355 J. H. Johnson, Lincoln's Inn Fields—Arrangement of piles.—A com.
3356 W. Fowler and J. Griffiths, Chesterfield—Tyres of railway wheels
3357 A. M. Clark, Chancery Lane—Ornamenting gauze.—A com.
3358 A. V. Newton, Chancery Lane—Making extracts.—A com.
3359 E. Belknap, Cavendish Square—Solution of malt for brewing
3360 H. F. Gardner, Charing Cross—Treating metals
3361 J. S. Smith, Bacup—Ventilating Buildings
3362 J. M'Farlane and G. Barker, Glasgow—Permanent way of railways
3363 S. A. Chase, Boston—Running mechanism
3364 W. R. Lake, Chancery Lane—Spring hinge
3365 M. A. Hamilton, Chancery Lane—Cutting implement

28th November, 1867.

3366 A. Mackie, Warrington—Composing and distributing type
3367 R. H. Bentham, Manchester—Facilitating the flow of liquids
3368 W. Palmer, Kilburn—Horses' shoes
3369 M. H. and L. H. Larmuth, Salford—Water meters
3370 E. T. Hughes, Chancery Lane—Tea and coffee pots.—A com.
3371 T. Carter, B. Carter, and J. Lisle, Huddersfield—Condensers
3372 W. Cotton, Hebden Bridge—Cutting woollen and cotton corduroy
3373 T. Rose, Oxton, and R. E. Gibson, New Brighton—Separating and cleaning seeds.
3374 E. T. Hughes, Chancery Lane—Sprinkler for powdered substances.—A com.
3375 E. T. Hughes, Chancery Lane—Pressing the edges of boots.—A com.
3376 T. S. Horn, Newcastle-upon-Tyne—Safety lamps
3377 J. H. Johnson, Lincoln's Inn Fields—Bricks.—A com.
3378 J. M. Napier, Lambeth—Vessels
3379 E. Wood, Bolton—Steam engines
3380 J. R. Pratt, Fenton—Earthenware
3381 E H. Bentall, Heybridge—Nuts and bolts
3382 J. Scholefield, St. Luke's—Covers for umbrellas
3383 J. R. Towers, Hereford Road—Bedsteads
3384 J. Baylis, Bristol—Panoline dye

29th November, 1867.

3385 W. R. Lake, Chancery Lane—Boiling and washing textile fabrics.—A com.
3386 T. B. Jordan, South Lambeth, and J. Darlington, Moorgate Street Chambers—Boring rocks
3387 J. Fraser and G. Duncan, Liverpool—Printing
3388 T. Rose, Oxton, and R. E. Gibson, New Brighton—Treating cotton seed
3389 C. Albisser, Mincing Lane—Sulphate of magnesia.—A com.
3390 M. F. Maury, Belsize Square—Protecting submarine cables
3391 H. S. Cowan, Kensington—Signalling on sea
3392 W. C. Houghton, Manchester—Hydraulic presses
3393 J. H. Johnson, Lincoln's Inn Fields—Grinding bones.—A com
3394 A. Turner, Leicester, and W. E. Newton, Chancery Lane—Carpets
3395 A. V. Newton, Chancery Lane—Washing and cleaning clothes
3396 A. M. Clark, Chancery Lane—Chronometers.—A com.
3397 J. J. Parkes, Paddington—Ventilating buildings

30th November, 1867.

3398 W. E. Gedge, Strand—Disconnecting locomotive engines.—A com.
3399 W. E. Gedge, Strand—Brake washer.—A com.
3400 R. Maclure, Barrow-in-Furness—Moulds for casting Bessemer steel
3401 T. Briggs, Manchester—Drying and stretching woven fabrics
3402 W. Starkey, Yeadon—Motive power
3403 W. R. Lake, Chancery Lane—Lubricating apparatus
3404 S. E. T. Steane, Barking—Globes
3405 W. R. Lake, Chancery Lane—Clarifying saccharine solutions
3406 S. Sharrock, Liverpool—Posts or uprights for electric telegraphs
3407 R. F. Compton, Tewkesbury—Couplings for railway waggons
3408 T. W. W. and J. F. Holmes, and J. B. and D. Lancaster, Baildon—Spinning machinery
3409 R. Clay, the Younger, Muswell Hill—Fire-arms
3410 J. Fitter, Birmingham—Expanding tables
3411 W. Priestley and W. Bower, Harden—Spinning machinery

2nd December, 1867.

3412 T. F. Widenham and J. Reynolds, St. Pancras—Easy chairs
3413 J. C. Woolfield, St. Albans—Boilers
3414 G. Heiron, Leadenhall Street—Castor for pepper
3415 E. Price, Hampton Wick—Gas burners
3416 C. and S. Hargrove, Birmingham—Bells
3417 W. R. Lake, Chancery Lane—Filtering syrup.—A com.
3418 J. H. Dean, Bilston—Handles for bails
3419 W. Schofield, Baxenden—Bleaching yarn
3420 D. Barker, Northfleet—Drying artificial fuel
3421 W. Black and T. Hawthorn, Gateshead—Valves for steam engines
3422 G. Philcox, Cleveland Street—Shoeing horses
3423 R. W. Page, Chelsea—Garden engines
3424 J. Hadley, Upper Thames Street—Drying corn
3425 G. Breen, Glasgow—Steam winches
3426 J. H. W. Biggs, Manchester—Warp ends
3427 F. Foster, Kingsland—Safety Lamps
3428 R. Porter, Birmingham—Buildings
3429 W. B. Leachman and J. Holroyd, Leeds—Leather shaving and dressing

3rd December, 1867.

3430 J. H. Wilson, Liverpool—Water-closets
3431 S. Vaile, Basinghall Street—Tables
3432 J. Collingham and T. E. Smith, Keighley—Spinning
3433 J. Eckersley and D. Martin, Edinburgh—Permanent way of railways
3434 J. G. Hope, Edinburgh—Utilizing mineral oils
3435 W. Shave, Sturminster—Rabbit traps
3436 W. Pidding, Walworth—Placing needles
3437 J. Thorpe, Manchester—Waterproof paper
3438 H. F. Gardner, Charing Cross—Bits and stirrups.—A com.
3439 W. Brown and C. N. May, Devizes—Portable engines
3440 J. Gjers, Middlesborough—Cast steel and homogeneous iron
3441 R. Hornsby and G. E Phillips, Grantham—Reaping and mowing machines
3442 W. Sangster, Cheapside—Umbrellas
3443 N. Grew, New Broad Street—Cleaning seeds
3444 F. R. Ensor, Park—Lace

4th December, 1867.

3445 C. Paley, Red Lion Square—Boots and shoes
3446 J. Sanders, Birmingham—Braces
3447 T. G. B. and B. Stephenson, Bradford—Waxing warps
3448 J. Newton, Leeds—Self-acting radial doffing knife
3449 R. M. Letchford, Bethnal Green—Circular boxes
3450 R. R. Gray, Glasgow—Metallic casks
3451 E. T. Hughes, Chancery Lane—Lighting.—A com.
3452 F B. Baker and L. Lindley, Nottingham—Ornamenting lace
3453 E. Walker, Pimlico—Breech-loading ordnance
3454 F. Jolly, Horwich—Clamping
3455 J. T. Webster, Mansfield, and W. Oxley, Manchester—Spinning
3456 J. F. Clarke, Moorgate Street—Melting snow
3457 W. A. Herring, Chertsey—Warming buildings

5th December, 1867.

3458 J. H. Johnson, Lincoln's Inn Fields—Blasting.—A com.
3459 D. Smith, Bury—Steam-boiler furnaces
3460 S. L. Worth, Oxford Street—Ladders
3461 J. Green, Lockwood—Breaking sugar
3462 J. Mabson, Newcastle-upon-Tyne—Bags for coffee
3463 S. Perkins and W. Smellie, Gorton—Malleable metal
3464 J. G. Scott, Edinburgh—Transmission of money
3465 J. Adams, Blackfriars Road—Dating railway tickets
3466 A. C. Sterry, Ewell—Heated air or gas
3467 M. Tildesley and J. Bird—Annealing furnaces
3468 T. J. Leigh, Cannon Street—Furnaces
3469 P. G. L. G. Designolle and J. Casthelaz, Paris—Explosive and fulminating powders
3470 E. A. Pontifex, Shoe Lane—Condensers

ON IRON SHIELDS AND OTHER ARMOUR DEFENCES.

By F. R. C., Lieut.-Colonel, R.E.

The subject of iron shields for guns in fortresses has been lately re-galvanized into public life by one of those misadventures at Shoeburyness that have so often before stirred up the public feelings. By misadventure is not meant mistake on the part of any person concerned, nor absolute failure, but only that a single experiment has been in its little way comparatively unsuccessful.

Not the first of such misadventures at Shoeburyness by very many; indeed, that place has been the arena of a series of exciting contests for the delectation of the dilettanti of London for many a dull season. The thousand and one targets of Shoeburyness may vie with the "Arabian Nights," if not in actual number, at least in idea. Like that celebrated entertainment, they profess to have been founded on a grand idea, and to be consistently working out a great principle; whereas to the lord public of London they have been nothing more than a series of independent episodes, each containing its own modicum of interest, but without any connection with those that have preceded it or with those that follow it: and that either stories or targets ever came to an end is probably due to the natural result that even sultans and lords public must get tired of a succession of little excitements of that kind in course of time.

When the government of a country begin seriously to think of making so important a change in ships and forts as to substitute iron for wood and stone, the reasonable mode of proceeding seems to be, to have carried on a considerable series of experiments on the material itself to test its qualities in various ways; and that these should have been conducted in such an elaborate and consistent manner as to enable scientific men to have deduced from them some laws for the application of iron to defences under various circumstances. Commencing with a certain well-considered apparatus, each element of that apparatus should have been varied by regular succession without disturbing any of the others; and thus the law of action of each element of the apparatus would have been ascertainable in turn. Such a course of experiments, to be effective, would have to be very long, minute, and tedious, and without apparent result until the termination of the whole.

The Shoeburyness entertainments were on a very different plan from this. A committee, however well selected, is not sufficient without a general plan of operations for their guidance; and the only general plan the committee seemed to have had given them to act upon, was to keep on trying targets till they got one that would stand any gun they could find. The result of such a plan of operations was naturally to excite the inventive talent of the country in heavy iron-work; and as fast as one set of targets was knocked down a fresh crop appeared, each fresh batch remedying the defects of their predecessors, and containing each some novelty more ingenious than the last, and each failing by some defect equally novel. Experiments went on accumulating, blue-books visibly thickening; and when they stopped at last, it was not that they had arrived at the end of a programme, or elucidated a theory, for no one of the scientific men engaged in the matter has succeeded in distilling from the mass of material any definite theory to guide military and naval architects in applying iron to ships and forts. All that was positively determined was, that a certain mass of iron and timber, arranged in a certain way, would not be completely destroyed by a certain number of shots from a certain gun fired under certain circumstances.

As this sort of conclusion did not provide a rule for guidance under different circumstances, it cannot be a matter of surprise that long after the original book was closed, and the original committee wound up, a fresh arrangement of the old targets becoming damaged by an old gun under new circumstances causes consternation and despair, and drives the public to the old remedy for all these ills, of a fresh committee, and perhaps a fresh edition of target entertainments.

The blame for such barren results cannot be laid to the original committee, for they acted under the direction of their employers; and the employers, if they had occasion, would doubtless be able to show that they acted under the higher pressure of that unknown quantity we call public opinion in England. The real blame probably belongs to that public which delights in action, incessant action, with progress or without, and feels a sensation of security in the multitude of counsellors.

But although no well-defined theory can be obtained from the experiments hitherto made, it is quite possible to lay down the outlines of a general theory on the effect of shot striking iron targets, with sufficient precision to enable us to form a fair opinion on the principle of any target construction; for the action of a shot striking an iron plate is of course little different from that of any other mechanical force deflecting the plate.

If any beam or narrow plate, supported at its ends, is acted upon by a pressure near the centre and perpendicular to it, and acting slowly, it bends to a curve; and as in consequence of the slow action the whole of the fibres or particles of the beam are brought into play, the resistance of it to such action varies directly as the number of fibres in the cross section, and as the depth or thickness, and inversely as the length of the beam. Again, the distance through which the centre of the beam bends from its original position varies directly as the pressure exerted, as the cube of the length, and inversely as the square of the depth or thickness, and as the number of fibres in the cross section. It is necessary this should be clearly kept in mind for a true idea of the principles of target-making. As the beam bends the fibres on the convex side become stretched, or rather it is in consequence of their stretching that the beam bends; the amount of that stretching varies directly as the cube of the length, and inversely as the square of the depth, and as the number of fibres in the cross section.

Again, the mechanical effect exerted to deflect the beam by a statical pressure, or one moving only with the beam, is the pressure multiplied by the distance through which it acts. If, therefore, we want to find the resistance of the beam to the mechanical effect exerted, we must combine the above two proportions together, that of its resistance to the actual pressure and the distance through which it has been deflected. The combination of these two shows that the whole resistance of the beam to the mechanical effect of deflecting it, varies directly as the length and breadth and depth or thickness of the beam.

Hence the mechanical effect required to be exerted to break any beam by deflection could be easily determined from the above proportions, with the addition of the necessary special coefficients depending on the material.

But when the body producing the pressure to deflect the beam is of comparatively small size, and moving with considerable velocity, another action takes place. An indentation or hole is made in the beam, not much larger than the striking body; and when the velocity is very great, a hole is sometimes made completely through the beam, as if it had been punched. In fact, the action of common hand punching is a precise case in point. This punching action is apparently chiefly due to the fact that a certain time is required for the transmission of motion through the particles of a body—a very small time in general, but an appreciable time; and that owing to this the fibres immediately about the part struck are crushed, torn, or otherwise put out of form before the whole of the beam is set in motion.

The resistance of a beam or plate to this action absolutely, that is to say, when so applied that no appreciable motion of the whole beam can take place, as in a plate-punching machine, varies directly as the diameter of the striking body and the thickness of the beam or plate. And the mechanical effect expended in punching a hole completely through, varies directly as the statical force multiplied by the distance it has passed through in the action; that is, therefore, directly as the diameter of the striking body and the square of the depth or thickness of plate.

With the addition of the necessary special coefficients for the material, the mechanical effect required to punch a given hole through a given plate, could be determined from the above proportion. The difficulty of applying these two general theories practically to the action of shot upon iron plates, is that that action is never completely a deflective action, nor completely a punching action, but always something intermediate compounded of the two together; and the law of the joint action of the two has not yet been determinable. While the shot is punching an indentation in the plate it is also deflecting it, and yet not deflecting the whole of it like a statical weight would, but bulging out only a part about the point struck. The diameter of the part bulged is virtually the length and breadth of the beam, as far as the deflective action is concerned, and it varies inversely as the depth of indentation punched, and that again varies with the velocity of the shot. Thus there is a variable element in the resistance of the plate depending on the velocity of the shot, and also upon the comparative resistances of the material to the punching action or the deflective action, *i.e.*, its malleability and its elasticity; and it seems impossible, in the present state of our knowledge of the subject, to determine with any degree of

satisfaction even an approximation to the law of the resistance of the joint action.

Hence, also, it is not possible to compare precisely the action of one shot with another in any terms common to both, for the resistance of the same plate to one is different in kind, as well as degree, to that to the other. An approximate comparison has been used at Shoeburyness in terms of the mechanical effect stored up in each shot on striking, and which appears to be of some practical use with guns and targets of the same class. But it is evidently imperfect for determining any general law for the application of iron as a material to these purposes. It is for this that some such elaborate experiments, as before mentioned, are necessary, before we can really tell whether we are proceeding on sound principles in our use of the material.

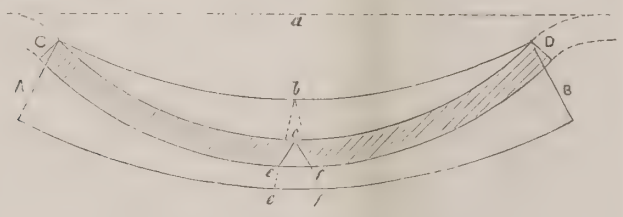
But we can draw a few conclusions from the laws of resistance to deflection and punching which will be of some value in considering the principle of construction of any target, as to whether it promises capability of greater ultimate perfection when the complete laws shall be established.

A beam or plate, of which the length between the supports is considerable compared with the breadth and thickness, requires a less mechanical effect to break it by deflection than to punch a hole in it; or, to resist the deflective action of the shot alone requires a greater thickness than to resist the punching action alone.

A corollary to this is, that to resist shot of hard material, small diameter, and great velocity (and, therefore, with a tendency to punch), the iron should be tough, malleable, of good tenacity, and in solid masses supported at short intervals. To resist large shot with slow velocities (and, therefore, with a tendency to cause deflection), the iron should be in large plates comparatively thin (*i.e.*, that the whole thickness may be made up of several plates), and of high elasticity and tenacity.

To resist deflection there is an advantage in using large square plates; for although, theoretically, the mechanical effect exerted is proportional to the length, breadth, and thickness, practically the shot always strikes with such a velocity that only the part about the point of impact is deflected, and, therefore, when the breadth of the plate exceeds the diameter of such bulge, it is, as it were, in the condition of a plate supported all round; the resistance to deflection is increased in greater proportion than the breadth, and the injury done by deflective rupture is not so serious to the whole structure.

There is a mechanical disadvantage in using large solid plates of great thickness to resist deflection. The total mechanical effect exerted to deflect the thick plate, A B, to the point of rupture, is much greater than that to deflect similarly the thin plate C D: but as the ultimate



extension of the bottom fibres, $e f$ and $e' f'$, is the same in both cases (being the extreme practical elongation the material will bear), the actual deflection of the thick plate ($a b$) is much less than that of the thin plate ($a c$), actually being inversely proportional to the cubes of the thicknesses. Consequently, there is a greater probability in the thin plate that the whole length of the plate will be brought into action to resist the deflection, whereas in the thick plate the chief strain will be thrown on comparatively fewer particles about the lower edge, $e' f'$, and therefore there will be the greater danger that any small imperfection in that part of the plate will cause rupture of the whole.

When large thick solid plates were first used at Shoeburyness, they were made as hard and elastic as possible, and consequently all broke by deflection; and the above consideration will probably account for the frequent cracks made in the back part of large thick plates to this day, though a more malleable material is used.

A target composed of layers of thin plates, placed back to back, will be more easily pierced than a solid plate, in the proportion of the square of the whole thickness to the sum of the squares of the small thicknesses.

A target composed of layers of narrow beams, placed side by side, will be more easily broken by deflection than a solid plate of the total breadth of all the beams together, in the proportion of probably the cube of the length to the length, if the plate is square.*

These two propositions apply to all descriptions of targets made of small pieces fastened together, or separated by backing or filling in of softer material—allowance being made in each case for the efficacy of the fastenings and for the nature of the backing; with this further consideration, that no description of fastenings, and no description of backing softer than the plate, are of much efficacy to resist deflection; whereas to resist punching, backing and filling in may be of great value, and the fastenings are of less importance.

Upon the whole, these few conclusions tell against the use of very thick solid plates of large area, and tend to drive us to adopt one of two methods—either thin elastic plates of large area, and let the shot punch holes in them; or thick ductile masses, supported at short intervals, in which the shot will bury itself.

In a practical point of view, the use of thick solid plates is more objectionable still. They are always likely to be more expensive than small plates, and more difficult to obtain, and difficulty is a serious question of delay in war stores. They are also more expensive and more difficult to move, and to erect, and to alter, and to repair. The question of repair is one that has been rather lost sight of by inventors, chiefly because they were dealing with ships, and a damaged ship can be carried to a dockyard for repair. But a damaged fort must be repaired on the spot; and a description of plating which could not be repaired or replaced by the means available in an ordinary fortress, would be as great a defect as elaborate machinery for working exposed guns.

Of the two systems towards which abstract theory seems to point, that of large thin elastic plates seems most adapted for ships, in which thinness of plating is an essential point; and that of thick ductile masses seems most adapted for forts, in which any required thickness may be used. The difficulty of joining small pieces together, sufficiently to prevent them opening and separating by the shock of the concussion, has hitherto been a bar to the further development of targets of this kind. More than one has failed at Shoeburyness from this cause.

Colonel Inglis, R.E., in 1863, I think, proposed a plan of iron fronting for forts, which, in the present state of our knowledge, seems likely to be the most practically efficient of any. Up to that time the attention of the Target Entertainment Committee had been chiefly directed to plating for ships. Colonel Inglis had been the officer of engineers superintending the construction of all the targets for the committee, and, profiting by the great experience he had thus obtained, he invented the system of *iron planks*. It attracted attention by its successful resistance to the 300-pounder Armstrong gun; and I believe that up to the present time, with the exception of the Hercules target, it is the only description of iron fronting that has given any effectual resistance to that gun. This success ought to give it merit in the eyes of the entertainment-loving public; and, in the absence of any good theory, it affords us the greatest prospect of efficiency, combining as it does other practical merits besides that of success. The essential principle of it consists in the use of *iron planks*, about 2 feet wide, 5 or 6 inches thick, and about 8 and 12 feet long; two or three layers of these are fastened together, one behind the other, the second layer being laid at right angles to the first, and the whole bolted together, and to a strong framework and skin of plate iron behind. It therefore has the defect theoretically attributed to beams, that each plank has a tendency to break by deflection, and that comparatively easily, and so become partially useless. This is to some extent counteracted by the transverse arrangement of the second layer of planks, and it may be further counteracted by the use of softer iron, and so more approximate to the theoretical system of thick ductile masses, in which the shot will bury itself. For its greatest practical merit lies in the facility with which its thickness, and therefore its resistance to punching, can be increased by adding fresh layers of planks, the alternate layers being laid transversely. In a system depending on resistance to punching, the number of bolts and rivets is of small importance as concerns that resistance. It is, of course, a matter of importance as concerns danger to the men inside from bolt and rivet heads flying off; but that is a danger common

* This conclusion, which it is but right to remark the author gives as only "probable," is much more than doubtful; in fact, the investigations of Navier as to the resistance of plates *encastré* all round, such as floors, prove that the question is one greatly more complex and difficult than here seems indicated.—Ed.

to most targets, and is one which must be met by special means adapted to the purpose on the inner side. But as far as resistance to punching is concerned, the target might be a mass of bolts and rivets.

Colonel Inglis' system has the further practical merit of being composed of materials not difficult to obtain, and not much more expensive than any good rolled iron of commerce, not difficult to move, and capable of being fitted together by intelligent smiths. A good evidence of the advantage of this facility of use has been afforded at Malta. Some iron shields, a modification of Colonel Inglis', arrived in Malta about the same time as the guns for them. The shields, being in pieces not heavier than 4½ tons, were carried up to their places in the fortress at once by the ordinary transport of the country, and could have been erected by the military artificers present. The guns, weighing 12 tons, had to be left on the wharf, to wait for special apparatus for transporting and hoisting them.

The iron shields sent out to Gibraltar and Malta, and those whose trial at Shoeburyness have caused this new anxiety, are, I believe, all a modification of Colonel Inglis' plan. Instead of planks, the armour is in large plates, about 8 feet by 4 feet, and in two thicknesses of about 5 inches each. The details of the trial not having been made public, we do not know the damage done, nor the shot that did it. But it would not be anything surprising if the 300-pounder Armstrong, with a chilled shot, damaged the plates at close range, though it is not probable that that gun could render it inefficient in a day's firing. Colonel Inglis' original planked shield which withstood it was in two thicknesses of 7 and 8 inches. Neither do we know why a shield of inferior strength to Colonel Inglis' was adopted for the above fortresses; but this we do know, that it is quite easy to increase the strength of these shields by adding another plate to the front of them, which will not alter the principle of them, nor add to the cost more than the actual weight of iron; and as it is part of the principle of this plan to be able to increase or reduce the thickness without altering the whole structure, it seems probable that some such intention existed of increasing their strength at a future time. It would be quite practicable to put up the shields with only one plate, or indeed with only the skin, and add on the others at any time when danger threatened or funds were available.

Three plates of 6 inches thick each, though not possessing the same theoretical strength as one plate of 12 inches thick, would be really more efficient to resist deflection, and considering the great increase in price of rolled iron of that thickness, and the increased cost of fixing, would not be more expensive; and considering the very much greater facility of repairing any damage done to one of the plates, the shield of several thicknesses is on the whole much preferable to a solid plate in one thickness.

To those, therefore, who consider this subject from a mechanical point of view, and not through the medium of sensational anecdotes of target life, there seems to be no reason for distrust of the principle on which these shields are constructed, merely because in their present thickness they have been damaged by a shot or two.

NOTE.—In the foregoing paper, written certainly with much clearness, we have been anxious to enable the distinguished officer, now on distant service, who has communicated it to us, to speak for himself, without a word of alteration or modification on our parts, the rather as the author has desired his paper to be printed with his initials only. We must not, however, be understood from that as either endorsing or even admitting all his views. We do most fully agree with him that a well-considered, carefully and quietly conducted train of experiments, made by some competent physicist upon the relations of iron and other structural materials to the impact of projectiles under various conditions, and the elimination of a few clear and certain theoretic principles, should have preceded any experiments on the vast scale at Shoeburyness or Woolwich; and we have long looked upon a great deal of the Shoeburyness experimenting as money in good part thrown away for want of such preliminary science, and for want of a more comprehensive appreciation there of Bacon's grand maxim, *Prudens quæstio dimidium scientiæ*. But it is one thing to see and say all this; quite another to improvise a theory of "target entertainment" that shall at all represent the truth, and the *whole truth*, as it is in nature. We feel bound to say that the outline sketched above does not do so. For us to attempt to show how and why it does not, would be almost the same thing as to sketch such a theory—here an impossibility, even if otherwise practicable. Two remarks, however, we cannot pass by. The author appears wholly to overrate the total amount of *difference* in resistance that can under any circumstances be obtained from iron through its entire range, from the very softest, such as charcoal scrap or Lowmoor, that will cut with a knife, up to spring-tempered cast steel, assuming the impact to be made in all cases at from 1000 to 1600 feet per second. He seems to us equally astray as to the actual facts of the trials made with Colonel Inglis' planked embrasures. These were utter failures at Shoeburyness, and from physical conditions affecting these iron planks and their arrangement, which do not appear to have occurred to the author. Even the far more likely modifications of this structure tried in embrasures by the Austrian service were found all to go to pieces under a very moderate cannonade.

If these Inglis' planks be the *pièce de resistance* of those Malta and Gibraltar embrasures, we can only say, woe worth the day that they shall be exposed to a pounding from any well-armed and determined enemy; better for gunners and for England that the guns were *en barbette*.—ED.

IRON METALLURGY IN 1867.

IT is difficult to record history during a revolution. Events crowd in upon each other in an apparently accidental coincidence, and the dense chaos of facts does not permit the searching eye to penetrate it with sufficient readiness for clearly tracing the connections between causes and consequences, and the mutual bearing which the different events have upon each other. The metallurgy of iron, this vast and all important branch of modern industry, is in the state of a great revolution at this present moment; and in attempting to review its position during the year recently past, we feel that we are called upon to mark the boundary line of a new era, and to write the introduction to a new chapter in the history of civilization. The general character of this revolution we may define in very few words. Iron metallurgy, *the art* of manufacturing iron and steel, is making room to modern iron metallurgy, *the science* of reducing iron from its ores, and of producing the different combinations of iron and of other elements, which are required for the various purposes of modern practice. With regard to theory and to practice, iron metallurgy is changing its character; the rule of thumb, the routine of "the trade," the acquired habit, both skill and prejudice, of former times are giving way before the all-conquering inroads of scientific discovery, mathematical calculations, and chemical analysis. We are unable to discern which precise steps in the advancement of abstract science have been the nearest causes for the recent changes in practice; nor are we able to point to any one of the great workers in that field of sublime research as the special pioneer in that direction. It is different with regard to practice itself. Here we see all the modern innovations group themselves round two distinct great thoughts, each of which forms the centre of an important system of discoveries and inventions. The two fundamental novelties are, the use of gaseous fuel, and the application of a forced air blast for the decarburization of iron. The use of gaseous fuel for the purpose of iron metallurgy commenced with the invention of closed blast furnaces; the utilization of waste gases gained ground on the Continent many years before it was practically introduced into this country, and it was only after the successful creation of the first large blast furnaces in the Cleveland district that the closed furnace became a recognized practical fact amongst British iron smelters. Blast furnace gases are now the only fuel used in the Cleveland district, and in the most modern ironworks in Lancashire, for firing the hot-blast stoves, the boilers, and, in some cases, also for working the calcining kilns of these ironworks. The economical employment of the fuel for iron smelting has in modern practice in Cleveland reduced the consumption of fuel for making a ton of gray forge pigs to 18 cwt. of coke per ton of iron produced. This is due to the construction of furnaces of very large sizes, the employment of blast heated up to 1000 degrees, and in some cases to a temperature exceeding this point, to the use of a blast pressure, varying from 4 to 7 pounds per square inch, and to the utilization of the total amount of furnace gases produced in the process of smelting. In Lancashire the most modern furnaces, such as, for instance, those of the Carnforth Hematite Co., or of the Wigan Coal and Iron Co., produce gray pig iron for the Bessemer process with a consumption of 20 to 21 cwts. of coke to the ton of iron; their furnaces are from 60 to 80 feet in height, and closed at the top by the well-known cap and cone, first applied at Ebbw Vale. The gases drawn off the furnace suffice for heating the stoves, and all boilers required for blowing engines and

hoists. At Barrow-in-Furness only a part of the furnace gases is utilized, and an additional amount of coal is therefore required for firing the hot-blast stoves; the furnace gases being only sufficient for raising the steam for the blowing engines and hoists. Such is the state of modern blast-furnace practice in England at this moment, but it is far from being the position of the general practice through Great Britain. In Staffordshire, in Yorkshire, and in Scotland, the majority of blast furnaces is behind the requirements of the day. A large consumption of fuel, the necessity to employ ores of the richest kind, and the production of an inferior quality of iron, are the evils generally existing in the old-fashioned blast-furnace practice of those districts; they raise the prime cost of the pig iron above its value in the market, and gradually place those old established and extensive ironworks on the verge of an impossible commercial position, in spite of their long-possessed world-wide fame and business connections.

The most important method for employing gas as a fuel now in practical existence, is the Siemens' furnace. This beautiful and highly scientific invention comprises two important principles, viz., the employment of gaseous fuel, and the regeneration of heat. It is not necessary now to describe the Siemens' furnace, or the mode of its working. We refer to our own columns, and we probably could refer to the columns of every engineering paper throughout the world, for descriptions and accounts of this great invention. The Siemens' furnace, like the closed blast furnace, has been introduced on the Continent long before British "practical men" could be made to believe in its merits, or even in its possibility of working. At present it will not be far from the truth if we state that this country has more Siemens' furnaces at work than all the rest of the world put together. In iron metallurgy, and particularly in the manufacture of steel, the Siemens' furnace has effected very important changes and innovations. It has facilitated the manufacture of the softer kinds of crucible steel, by affording a higher and a more uniform heat, and a clearer flame than the furnaces previously known. It has economized fuel and prevented waste of material in the process of reheating steel ingots and forgings, by affording a neutral flame of constant and easily regulated temperature, and therefore preventing the oxidation of the metallic surfaces. It has made the most inferior kinds of coal slack, of lignites, of peat, and in the case of M. Lundin's furnace at Carlsdald, in Sweden, it has made even damp sawdust a suitable fuel for producing the highest heats required for puddling and welding iron, or for melting steel. The Siemens' furnace has given rise to several new modes of making steel. MM. Emile & Pierre Martin, of Sireuil, in France; M. F. Bérard, of Paris; and several other more or less successful inventors—have patented and introduced methods of steel manufacture to which we have had occasion to refer in an article, p. 235, present volume, and Mr. Siemens' has also patented a new process of steel-making direct from the ore, by the application of his gas furnace. A furnace which practically affords some of the advantages of the gas furnace is that invented by Mr. E. B. Wilson, now in use at Messrs. Hick, Hargreaves, & Co.'s works in Bolton; another furnace still closer approaching the character of the Siemens' furnace is that patented by Mr. Gorman, and recently introduced at the Lancefield Forge, Glasgow.

At the head of the second group of revolutionizing inventions stands the Bessemer process, that great invention amongst the greatest, that wonderful achievement amongst the most wonderful feats of modern engineering. The Bessemer process is only twelve years old, and only five years in practical existence. In that short span of time it has raised important towns upon previously unoccupied land; it has peopled large districts; it has raised the wealth of the British nation, and the wealth of every other country, by an almost incalculable amount. It has diminished the consumption of fuel in the manufacture of iron and steel; it has reduced, and in many branches even entirely abolished, manual labour in those metallurgical processes which formerly demanded the greatest physical exertion. To produce a ton of best Yorkshire bar iron from the pig, the necessary consumption of coal exceeds 5 tons, while a ton of Bessemer steel bars can be made from the pig iron with a consumption of fuel averaging between 1 and 2 tons, according to the method of melting and re-heating employed. The Bessemer process has made steel the staple article and the principal material for modern engineering construction; it has doubled the strength of our standard material, and has, therefore, more than doubled our powers of overcoming natural difficulties in the erection of permanent structures, and in the construction of machinery. Bessemer steel has been employed for a large suspension bridge at Prague, and for a beautiful arched bridge upon the Champ de Mars in Paris during the last year. The Bessemer process, as far as is known at present, is restricted to those kinds of pig iron which are practically free from sulphur and phosphorus; and this only dark speck in the brilliancy of M. Bessemer's invention has caused a very depressive effect upon the iron manufacture of some districts. It is possible that a part of this depression may, at no distant time, be remedied by the introduction of another new method of using forced atmospheric blast for the decarburization of iron, viz., the Richardson process. This recent invention has been brought before the public with sufficient prominence, and only so short a time ago, that it is unnecessary now to dwell upon its peculiarities or details. The prospects of the Richardson process are very important, considering the large preponderance of phosphoric and sulphurous pig-iron in Great Britain, and in many other countries, which are all unsuitable for the Bessemer process, and for the working of which in the common puddling furnace the Richardson process is likely to afford considerable qualitative and economical advantages.

With the practice of iron metallurgy, the theory of the strength of materials and the experimental knowledge of the cohesive powers of iron and steel under different kinds of strains has advanced at an equally rapid pace. Dr. Fairbairn has laid a series of most valuable tests of the strength of steel before the British Association at Dundee. M. Wohler, in Prussia; M. Knut Styffe, in Sweden; and M. J. von Stumm Traunfels, in Austria—have made and published some interesting tests upon the fatigue of steel, or its power to resist the action of repeated strains.* The reference to the chemical analysis of iron and steel is gradually becoming a matter of every day's practice. The aid of the microscope is invoked for examining the crystalline texture of steel, and scientific research takes the place of business routine and practice in every branch of iron metallurgy.

ON SOME POINTS OF PRACTICE IN IRON FOUNDING.

No. XXIV.

PATTERN MAKING.

The adaptation of machine moulding from permanent metallic patterns, and still more the invention of repetitive moulding machines for toothed gearing, have somewhat diminished the importance of the pattern-maker's art to the iron founder. The joiner's art, in its special application to pattern making, as well as the various other arts or methods by which models or patterns are produced, will, however, always continue to be of an interest and value to the iron founder that they should be thoroughly understood.

The refinements of machine moulding are things of our great European centres of art and industry. They are not to be found generally by the iron founder starting to work in our colonies or in half-civilized foreign countries; and yet in these very places often it is that toothed wheel patterns, deemed the *chef d'œuvre* of the wood pattern maker's craft, are most needed for corn mills, mining work, and so forth.

The "pattern," or model, as the name infers, is the form in some solid material of which the casting is to be the *copy*. But this copy has to be taken through the mould—the casting itself but the copy of a copy; and as all three materials—the pattern, the mould, and the casting—have involved in their respective natures conditions which alter or modify the forms or the dimensions, or both, impressed by one upon the other, so the exactness of the final copy (the casting) from the original one (the pattern), or, as in truth we may say, from the still earlier original (*the design*), requires attention to a good many circumstances at each step of advance.

The pattern once made changes its volume and its form, or both, by change of temperature or of moisture and dryness. The mould does the same in very various degrees, as it is differently fabricated. The casting "contracts," *i.e.*, diminishes in volume, and often changes its form also, in process of the cooling and solidification of the poured in liquid metal. But as the pattern must be got out of the mould after it has left its impress within its material, and must "lift" or leave the material of the mould uninjured on quitting it, so must the cavity of the mould be slightly larger than the volume of the pattern. Thus it comes that "the allowance" made for "shrinkage," as it is called, is not measured by the contraction of the metal cast, between its temperature when poured and that of the atmosphere of the place or of where it is to be

* All these experiments have been carefully collected and recorded by our able contemporary, *Engineering*, vols. iii. and iv.

employed, but is to be the difference between the finished size of the mould and the intended size of the casting. In losing sight of this, as a metallurgic professor not habituated to foundry practice would be likely to do, Dr. Percy has fallen into a slight error in his large volume on Iron when he says, "Generally in foundries the amount allowed for contraction of gray pig iron after fusion is 1 per cent., so that patterns should be made larger in that proportion." In this he quotes from the "Traité" of M. Flachat, who probably had adopted the same error.

The common allowance made between pattern and casting is $\frac{1}{96}$, or $\frac{1}{8}$ of an inch to the foot for small or moderate-sized castings, and $\frac{1}{120}$, or $\frac{1}{10}$ of an inch to the foot for large and heavy ones. But neither one nor the other represents the contraction of the metal *only*, but that *plus* the shake or clearance between the pattern and the mould. The latter is extremely various. In the old and still usually practised methods of hand moulding in greensand, the amount of shake or clearance is necessarily considerable; and greater in the use of large and heavy patterns than with smaller ones, and more with some forms "hard to draw" than with others. But with fine and accurate machine moulding, the clearance is always reduced to a very small amount, and with some forms, such as shot and shell or pipe moulding, becomes almost evanescent; and here the difference in volume required between the pattern and casting will scarcely exceed the actual contraction in volume of the metal itself in cooling. As this contraction is by the workman always estimated not by volume but as lineal contraction, so in this case "the allowance" would be no more than almost equal to the lineal contraction of the metal. Here again, however, a disturbing condition comes in; for the total lineal contraction of cast iron in cooling is not the same in all three dimensions of any casting, and the difference varies with every difference in form and absolute size, as well as with every variation in the "mixture" or quality of the liquid cast iron, and in its absolute temperature at the moment of cooling. Even were this not so, strange to say, nobody as yet knows, even approximately, what is the total dilatation or contraction, linearly or in volume, for any one sort or any average sort of cast iron between, say, zero and the temperature of liquidity.

General Roy determined the linear dilatation for 1° Fahr., for the range between freezing and boiling water, to be $\frac{1}{162000}$ of the total length; and if we adopt the late Mr. Daniell's *corrected* number and take the fusing temperature of cast iron at 2700° Fahr., and that its dilatation is uniform through the entire range from zero to fusion (which is certainly below the truth, because the co-efficient of dilatation of all bodies appears to increase as the temperature approaches that at which a change of state, as from solid to liquid, or liquid to gas occurs), then it would follow that the total dilatation or the entire amount of lineal contraction would be $\frac{1}{60}$; but it is well known to iron founders to be nothing even approaching that, inasmuch as "mould clearance" and contraction together are practically found to range between $\frac{1}{96}$ and $\frac{1}{120}$ as above stated.

The co-efficient of total contraction given by the late Mr. Mushet must be equally erroneous; he gives it as from $\frac{1}{98}$ to $\frac{1}{85}$ of the length, unless indeed he *means* contraction and mould clearance together.

No more acceptable gift could be conferred both upon the iron founder and the engineer, by the experimental physicist, than a new and rigid determination of the total dilatation and contraction of cast iron for the entire range from zero to liquidity. Lavoisier and La Place, Smeaton and Troughton, have with great exactness determined the co-efficient of dilatation of steel and wrought iron in various states; but cast iron has been almost totally neglected.

From all these circumstances it results, as is sufficiently obvious, that the pattern maker has no rigid guide for fixing the excess in dimensions of the model above the intended casting. The old empiric rules afford a certain rude guide, but a very insecure one; and thus in making long girders or bridge castings, or even the parts of large engines or framing, the result is a matter of conjecture within narrow limits; and the error, if any, having been discovered by measuring the first casting made from the model, is corrected as respects subsequent ones, if need be, by altering the model itself, or by a little more or less liberal "knocking in the sand" for clearance, if it be a greensand casting. Again, in dry-sand moulds made from patterns, the mould itself shrinks in the drying, and the more as the drying is prolonged and conducted at a higher temperature; and here the moulder is compelled to resort to careful measurement of the finished interior of the mould itself, to insure the proper size. In this case, though the conditions are more complicated, the final result is easier arrived at than in moulding in green sand, for generally the moulder can either reduce the size of the cavity of his dry-sand mould in any desired direction, by laying on coat over coat of clay and black wash, or enlarge it by rubbing off the dry sand or loam with a suitably shaped piece of wood.

In this way a greater degree of accuracy as to final dimensions can be secured in dry sand or loam than in any other form of moulding; and were it not for this, that beautiful adaptation of size in the "trimmed" castings to their finished dimensions for the several parts of a large land or pair of marine engines, which is found to prevail in first-class establishments, could not be maintained. It is not unusual for a large cylinder, for example, to be cast with an allowance for subsequent boring out of not more than $\frac{2}{10}$ or $\frac{1}{4}$ all round the interior, and that heavy and complicated engine framing with hollow parts, like condensors or hot-wells, &c., shall go together with but little more allowance on the mutually bearing surfaces for planing off to joint. A large number of 36-inch spherical bombshells were cast at Lowmoor by government in 1854–55, which did not differ in calibre, one from the other, more than about $\frac{1}{10}$ of an inch, and subsequently a number were cast in the Arsenal Foundry at Woolwich which beat that degree of exactness hollow.

It sometimes occurs that a wood pattern is made, from which a casting is made, which in its turn is intended to become a permanent "iron or brass pattern." In such cases what the pattern-maker calls "a double shrink" must be allowed, *i.e.*, the wood pattern must make the first casting as much larger than the final objects to be cast are designed to be, as shall admit of their shrinkage after its own.

This is a little more complicated in the case of brass patterns than in those of cast iron, because we have to deal with the co-efficients of dilatation of two different metals—cast iron and brass, or possibly red gun metal; and none of these co-efficients are known for the entire range we need. Generally, however, we can here resort to the "trial and error" plan, as with the dry-sand mould, and take care to cast the metallic pattern somewhat too big, and cut off the surplus by proper tools. A difficulty not so easily met, however, occurs in some metallic patterns, such, for example, as those for large flat flanged plates, as those of railway water tanks, brewers' coolers, or bridge flooring before wrought iron for that purpose took the place of cast. In these it often happens that "core prints" or "paps," or such like projections, have to be placed on the patterns at rigidly-defined spots over the surfaces or flanges. It will seldom or never be found that these retain exactly their relative distances as fixed on the wood pattern, after that has been converted into the cast-iron pattern, and in the castings made therefrom, and it is frequently a matter of great difficulty and cost to alter their positions, and yet a necessity. We have found the best practice always, when the patterns are large, is to cast them free of all such core prints, paps, or other projections; to cast these separately, and then to pin them on in place, or secure their position on the pattern by steady pins. Metallic patterns of this large size are never needed, unless a great number of castings are required, which a wood pattern would not outlive; or that time urgently presses, and that a number of patterns are wanted to work from simultaneously, in which case the cheapest and quickest method of getting them to work is usually to cast them from a single wood one.

Very various are the substances which have occasionally been employed for the material of iron founders' patterns. The following are amongst the most usual and important, viz., various timbers, of which the first below embraces those most used in Europe, and most suited to the purpose, together with their specific gravities:—

American pine,	0·368
American fir,	0·403 to 0·465
Cowrie,	0·579
Honduras cedar (red),	0·550 to 0·561
White poplar (various species),	0·338 to 0·529
Willow,	0·410 to 0·490
Sycamore,	0·590 to 0·620
Pear tree,	0·661
Maple,	0·755
Lime tree,	0·604
Cherry tree,	0·715
Apple tree,	0·793
Alder,	0·800
Beech,	0·850
Mahogany (Honduras),	0·810 to 1·063
Boxwood,	1·030 to 1·330

Of metals, cast-iron, brass, red gun metal, zinc, and plumbers' solder (lead and tin), with type metal, have been employed. And amongst

other substances in occasional use are—loam (of the foundry), plaster of Paris, Roman or Portland cement, modellers' wax (a compound of glue and molasses for flexible moulds), glass, pottery, papier maché, and some others of very exceptional use.

The choice of timber for pattern making rests upon some general considerations as to the properties of the wood common to all patterns to be moulded from in sand, and upon some others which have relations to the special form and size of the intended patterns; in a word, the special object in view. In general, light, stiff woods, with fine close grain, and no very largely developed annual rings, straight grained, and free from knots, and such as without being *very* soft, are yet soft enough to be readily worked by joiners' and other tools, are best. But the *nature of the grain* of the wood is also important. Many hard and stiff woods might make excellent patterns, were it not for their tendency to split; teak, sabicu, and green heart are examples of these. Any timber, therefore, in which the "spiral vessels" are largely developed, and upon which the strong tendency to split when sawed into planks much depends, is unfit for the pattern maker. Again, any timber in which the annual rings or hard radial plates are largely developed, will generally prove an inferior pattern wood, though to this there are some exceptions. The grain of some timbers is such that no pattern can be made from them, which will "deliver" or "draw" cleanly out of the sand, unless by closing it up superficially by paint, varnish, or the like. This is the case with oak, elm, and many varieties of mahogany. But, further, the grain of some extremely fine-grained and perfectly uniform timbers, such as of sycamore, maple, and even box, is such, that, while the surface of a pattern made of these remains clean and dry, the sand clings to it in the most surprising way. This appears in reality to arise from capillarity; the pores of these woods are so small and fine that they *suck in* the moisture of the sand in contact with them, and as the moisture is already held in the sand itself by capillarity, so there is here an antagonism of one capillarity against another, and the sand itself is dragged up into intensely close contact with the wood, and so adheres to its surface. Patterns of such woods must be coated on the surface in some way; of which more anon.

Besides observing these general relations of pattern woods, we must choose amongst suitable woods the most suitable for the special pattern about to be made. In Great Britain, yellow or white pine, and white fir, with American red cedar (which makes beautiful patterns), and various light mahoganies, are the woods most universally applicable to all sorts and conditions of patterns. For small or moderate-sized patterns, whether for brass or iron, beech, maple, sycamore, and mahogany are those most used and justly preferred, especially for such patterns as are chiefly fabricated in a single piece, and in the lathe.

One grand general requisite is that the timber be as little liable to cast or warp, or change its dimensions and form in further desiccation after the pattern is made, as possible. It is one evil of sycamore, which makes beautiful small patterns otherwise, that its tendency to warp and buckle thus is very considerable. It shares this with beech and maple also, and these timbers have the further evil that in further drying, even of the most seasoned specimens, the shrinkage is extremely unequal in the direction of the grain, and in two orthogonal directions both transverse to it, so that patterns made of these woods, after lying by some time, are found to have changed form altogether; thus, a circular disc becomes an irregular oval, and alters its thickness unequally, according to which way the plank was cut out of the tree trunk. Box or other such hard woods are seldom used for patterns for iron, except for very small work, and for such brass or iron patterns are in the end preferable. For long or flat and approximately straight work, such as engine beams or connecting rods, lathe beds or head-stocks, girders, and framing generally, there is nothing better when the work is of moderate size than white or yellow pine. It is beautifully fine grained, and smooth in surface after the plane or chisel, casts very little, and even in wide surfaces is not excessively likely to split, and is so soft that it is easily wrought and admirably light to handle. For very heavy works, however, of the above classes we have found pine too soft, and liable to injury in the rough usage to which very large patterns must be submitted; their surfaces get deeply dinged or cut, and the wood is not unfrequently split. We have with much advantage substituted for it Canadian red pine, which is a good deal harder, and yet which, if judiciously chosen in the log, can be obtained free from gross knots, and from any such ring veins rich in turpentine as would be objectionable. No timber of the fir tribe rich in turpentine, it is scarcely needful to say, is fit for the pattern maker, though some terebinthaceous trees do afford very tolerable pattern woods. We have known the timber of the Fhuja, or Turkish cypress, for example, employed; and that of the evergreen oak, which is by no means a very hard wood, as might be imagined from its name, is used in Italy, where it is plentiful; so also the cherry tree, which grows to a very large size in Germany, though not free from gummy or resinoid secretions, when well chosen and seasoned makes as beautiful patterns as it does fine cabinet work. For large wheel patterns, or others requiring to be built up in "plies," and then turned in the large wheel pattern-makers' lathe, white American fir, or spruce, is by far the best timber. When cut into thin leaves and slowly and thoroughly seasoned, it no longer splits; it is much harder than yellow pine, or even red Canadian pine. It takes glue, which here is indispensable, well, and the plies, when laid on each other with the grain crossed diagonally, adhere tenaciously; and when in turning the edges of the plies are cross cut in the lathe, they take a very fine and beautiful surface in the hands of a pattern maker who knows how to treat it. As there is a good deal more to say about pattern making, we shall pursue the subject in our next article.—Ed.

MONS. LEGRAND'S SYSTEM OF CHAIR SLEEPERS FOR MINE AND COLLIERY RAILWAYS.

Examples of these were shown in the great Belgian Annexe, in the Park at the late Exhibition at Paris, and they are illustrated by the accompanying figs.

For the smaller gauge and lighter class of railways, incidental to colliery or like uses, Mons. Legrand, who is an engineer of Mons, in Belgium, constructs the cross sleepers and chairs in a single piece, and out of rolled trough iron. The straight piece of trough iron of the

Fig. 1.

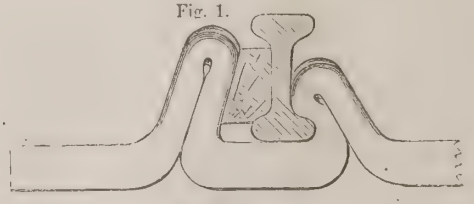


Fig. 2.

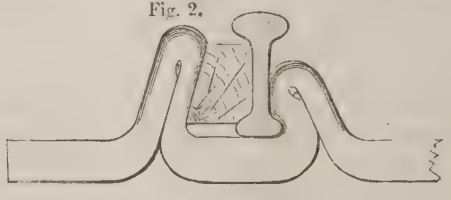


Fig. 3.

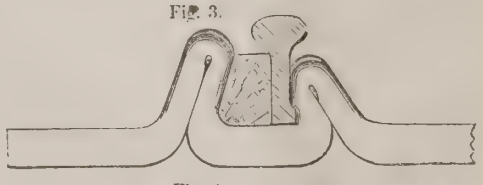
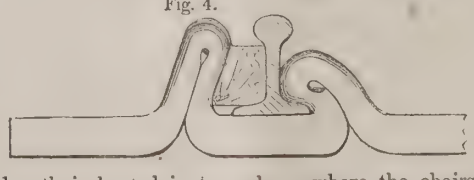


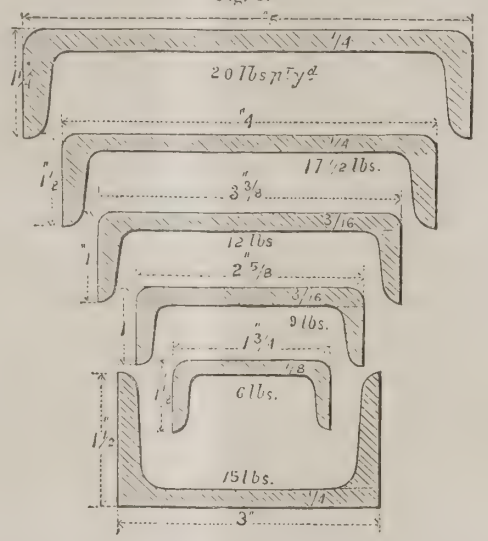
Fig. 4.



requisite length is heated in two places where the chairs are to be formed, and for a sufficient length, to a very bright yellow heat, and then by the aid of a special system of tools the trough iron, with the flat side uppermost, is bent and doubled up, and partly deformed as to its trough form, so as to produce two hooked transverse furrows at the desired distance to suit the gauge, and which answer the purposes of chairs. The figs. show the way in which, by wooden keys, the rails of any of the established forms can be wedged into place in these. The transverse sections of trough iron, shown with their actual dimensions, are those generally employed. The weight of one sleeper will

be found by adding to the weight of trough iron given by the width of gauge, the weight of from one-half to three-quarters of a yard *more*, of the size of trough iron employed. These sleepers are employed largely in collieries in Belgium, and have also found their way into one or two in England, at Chesterfield, Derby, and Sheffield. They appeared, judging from those at Paris, capable of standing a good deal of hard work, and are very cheap, and simple in construction. We should deem these sleepers likely to find many useful adaptations in our colonies, and for certain agricultural purposes at home. There seems but one conceivable possibility of their not answering—viz., if laid

Fig. 5.



upon uneven bottom of bare rock or packed-up stone; for, as some slight brittleness must be engendered in the trough iron where bent and doubled up so unceremoniously, it might now and then break off at the points of flexure, but this is a very minor if a tenable objection. The system has been brought before the Northern Mining Institute at Newcastle recently, but it is too simple, and too cheap, to easily commend itself to the habits of mind of English engineers of any class.

WEST CUMBERLAND PIG IRON.

THE position which this pig iron has during the last four or five years occupied in this country, as the only really valuable source of all British irons yet worked from which Bessemer metal has been or can be successfully made, is sufficient reason for our devoting a special article to its consideration. We should have done so before but for the reason that we hesitated to write on it previous to our possession of a sufficient quantity of thoroughly reliable data to enable us to inform our readers in a complete and systematic matter. The quality and amount of information approaching the standard at which we aim is not at any time to be quickly obtained, on account of numerous interfering causes; and therefore it frequently happens that journalists who desire their writings to be as completely as can be of a nature that may be relied upon, have to wait before the requisitions equivalent to the standard they adopt for themselves can be complied with.

So far, then, as the West Cumberland hæmatite ores are concerned, it is sufficient to state that the knowledge of their existence is of very ancient date; indeed, there are weighty reasons extant indicative of their having been worked by the Romans. Since the time, however, of the occupation of this country by that people under the generalship of Cæsar, until quite recently, these valuable deposits appear to have been allowed to remain untouched, principally on account of the difficulty of reducing the ores into the state of metallic iron other than by smelting small quantities of it in combination with some other easily reduced ores. The peculiar characteristic of the iron made from these ores is *red shortness*; still, by combining the Cumberland pig-iron with others, a metal is produced of greatly improved quality: so great is the advantage in this respect that large quantities of it are transported to various works in this country for the purpose of being mixed with the other pig-irons. The pig-iron is further peculiar in containing a remarkably small proportion of sulphur and phosphorus, and on this account it has been chosen, *par excellence*, above all others British produced, as that alone fit to be used for the manufacture of Bessemer steel. Indeed, it is a fact that Mr. Bessemer's great invention has been the chief stimulus to the investment of the capital necessary for the working of those rich deposits in the neighbourhood of West Cumberland, near the town of Cleator. We are now fortunate in having lately met with a very valuable pamphlet on the subject by Mr. E. G. Tosh, Ph.D., of Maryport, who appears to have devoted especial attention to these iron deposits and the products obtained from them. So valuable do we deem his contribution that we give abstracts from his writings in the subsequent part of this paper.

In West Cumberland the so-called hæmatite iron ore is irregularly distributed over an area of about 20 square miles (English). Its geological position (not very definite) is generally between the carbonaceous limestone and the millstone grit, resting upon the former, and overlaid by the latter formation. It is not found stratified, but in large irregularly shaped masses or "pockets;" at other times in long sinuous veins which vary much in size in a few feet, expanding suddenly from a small "runner" to a large deposit many feet in depth and breadth. In some cases these beds of ore attain the thickness of 30 feet, and even more; but as a rule, they are only about a fourth of that size. It is found at various depths beneath the surface, and in some cases lying exposed at the surface of the rocks.

The mineral belongs to the class of red hæmatites, that is, those iron ores consisting essentially of anhydrous sesquioxide of iron, and it is met with in four different conditions. 1st. Amorphous or massive, very dense, fracture conchoidal, and of a cold blue colour. 2nd. In mammilated concretions, locally called "kidney ore." When broken, this variety displays a radiated, fibrous structure, of brilliant silky lustre, and bluish steel-gray colour. 3rd. A pulverulent variety, so soft that it may be rubbed between the finger and thumb. 4th. As specular iron, crystals of which are frequently found, though generally very small. By the aid of the microscope their characteristic six-sided rhombohedral form is distinguishable. Crystallized quartz is very commonly associated with this ore, and, less frequently, sulphate of baryta and bitterspar.

The following analyses of the various varieties show the elementary constitution of these ores:—

	I.	II.	III.
Sesquioxide of iron,	95·16	86·50	97·30
Protoxide of manganese,	0·24	0·21	0·13
Alumina,	0·06	0·30	—
Lime,	0·07	2·77	0·22
Magnesia,	—	1·46	—
Sulphuric acid,	trace.	·11	—
Phosphoric acid,	trace.	trace.	trace.
Carbonic acid,	trace.	2·96	0·18
Silica,	5·66	6·25	1·62
	101·19	100·56	99 95

The first two analyses are from Dr. Percy's "Metallurgy of Iron and Steel." I. is described as "a compact red hæmatite; it contains cavities lined with crystals of specular iron and quartz." II. is "red hæmatite of the unctuous variety." This ore, though not so rich in iron as the harder varieties, is preferred by ironmasters for the manufacture of the best iron. It contains a notable quantity of lime, which at a high temperature in the blast furnace neutralizes any silica present, forming slag, thus preventing its reduction and the consequent formation of a highly siliceous and inferior iron.* III. is a very rich ore analyzed by Dr. Tosh. As shown in the analysis, it is almost pure sesquioxide of iron, and was softer than the more common varieties, besides showing distinct marks of stratification.

It was formerly supposed that hæmatite was a product of igneous action; now, however, an aqueous or infusorial origin is assigned to it.

The extraction of the metal from the ore is chiefly carried on in the vicinity of the mines where the ore is obtained. The blast furnaces are situated at Cleator, Workington, and Harrington, their usual dimensions being very large, namely, height about 50 feet, diameter at the boshes about 17 feet. The blast is introduced into the furnace by six twyers, at a pressure of 2¾ to 3 lbs. on the square inch, at a temperature varying from 600° to 700° Fahr., or 315° to 370° Cent. Blast area about 50 square inches.

In the manufacture of ordinary iron the coke of the district is used as fuel, the fluxes being limestone and shale; and generally along with

* Percy, "Metall. of Iron and Steel," p. 199.

the hæmatite a small portion of some other ore or ironstone is introduced into the furnace. When pig iron is required for Bessemer steel, soft hæmatite ore, coke as free as possible from sulphur, and limestone, are the only materials employed. The Newcastle coke, generally selected, contains 0·78 per cent. of sulphur. The limestone used as flux is from the carboniferous measures, and has the following composition :—

Carbonate of lime,	96·018
Carbonate of magnesia,	3·030
Carbonate of protoxide of iron,	0·571
Phosphate of lime,	0·026
Sulphate of lime,	trace.
Organic matter,	0 096
Water,	trace.
Sand and clay,	0·962
	100·703

Coke made from local coal, as compared with that from Newcastle, is very rich in sulphur; and the effect which the use of a sulphurous fuel has upon the composition of pig iron may be seen by comparing Nos. I. and V. in the tables of analyses of irons given subsequently: in making No. I., Newcastle coke was used, and No. V., the coke of the district.

The consumption of coke in the production of Bessemer iron is much greater than in the manufacture of ordinary kinds, being increased about one-half. A more elevated temperature is thus attained, and the iron takes up a larger amount of carbon, which under certain circumstances separates again in great part on cooling. A large proportion of free carbon is an essential qualification of Bessemer iron. By the use of an increased quantity of fuel, ironmakers generally succeed in obtaining an iron rich in carbon, but which unfortunately does not always contain that carbon in the graphitic or uncombined state. Thus occasionally from the same "tapping" a large part of the iron is white, and, for the Bessemer process, is useless, while another portion, in some cases not amounting to more than one-third of the whole, contains graphite abundantly disseminated through it in large scales, and is the product desired. The formation of white iron is a great loss, and it is in all probability produced by the too quick cooling of the molten metal, at least if we may adhere to the opinion of Karsten, who demonstrated that if raw iron be fused and allowed to solidify very gradually, most of its carbon separated as graphite, while if cooled suddenly, white iron resulted. If a means could be contrived by which this too rapid fall of temperature could be prevented, it is highly probable that the loss by formation of white iron would be much diminished. In this way Karsten, as it appears to us, in a most satisfactory manner explained the process of chilling the chilled and outer parts of a casting containing only combined carbon, whilst the interior and slowly cooled parts contained it in the graphitic or uncombined state.

The composition of Cumberland hæmatite pig iron is well explained by the following five analyses :—

	I.	II.	III.	IV.	V.
Iron,	93·552	93·100	92·850	92·798	92·802
Graphite,	3·082	2·952	2·997	1·902	1·879
Combined carbon,	1·265	1·235	1·134	2·186	1·892
Silicium,	1·389	2·286	2·706	2·714	2·753
Sulphur,	0·068	0·075	0·068	0·065	0·164
Phosphorus,	0·027	0·055	0·028	0·030	0·055
Manganese,	0·216	0·288	0·140	0·140	0·288
Titanium,	0·006	0·006	0·007	0·007	0·005
Nitrogen,	0·056	0·041	0·051	0·051	0·049
Arsenic,	trace.	trace.	trace.	trace.	trace.
	99·661	100·038	99·981	99·893	99·887

I., II., and III. are from Cleator, Harrington, and Workington respectively, and were all specially manufactured for conversion into the best varieties of Bessemer steel. In appearance they were much alike: the fracture presented a bold crystalline structure, due to the graphite disseminated through the mass in large scales. IV. is a pig iron likewise intended for the production of steel, but on account of its containing too little free carbon or graphite, could not be successfully employed. Like the first three specimens, its fracture was highly graphitic, but in an inferior degree. V. is the analysis of ordinary gray forge iron made at Harrington.

The effect of the various elements of pig iron during its conversion into steel by the Bessemer process, will be evident from the following considerations :—

Highly graphitic pig iron is melted and run into "the converter," in which air is blown through the metal from beneath, the carbon and silicium are oxidized, and by their combustion produce a heat so intense that, in from fourteen to thirty minutes from the commencement of blowing, the resulting (almost pure) *iron*, at a dazzling white heat, may be poured out of the converting vessel in a stream almost as liquid as water. If *steel* be required, the necessary quantity of spiegeleisen (containing a known proportion of carbon) in a molten state is added to the decarburized iron in the converter, previous to running the metal out into ingots.

If now, white instead of gray iron be introduced into "the converter" and air blown through it, the heat does not increase, no carbon or silicium is burned. This different behaviour of white and gray iron is remarkable, as up till the present time it has been the opinion of metallurgists, if there was a definite one on the point, that the internal arrangement of the various kinds of cast iron was very similar when in the molten state. The phenomena here presented would seem to point directly to the conclusion that the two varieties of iron, gray and white, retain in the molten state, at least to a certain extent, the constitution they possessed when solid. Karsten states that graphite in fused graphitic iron may exist either in chemical combination or in mechanical solution. The different deportment of gray, as distinguished from white iron, inclines us to the latter opinion, or an approximation to it; for besides simple solution of graphite in the mass of metal, we may admit the existence of a high carbide of iron, necessarily a much more unstable compound than that existing in white iron, and the carbon of which, being in a somewhat weak state of combination, may combine more readily with the oxygen of the air at a high temperature. Further, either the graphite or this high carbide of iron may be dissolved in a second lower carbide, nearly resembling white iron in composition. Of course any premises as to the state in which carbon occurs in iron must be in a great measure hypothetical, on account of the extremely limited and imperfect nature of our knowledge of the carbides of iron. One conclusion, however, we may draw with probable safety, namely, that the carbon at a temperature not far above the melting point is very differently distributed in gray and white iron respectively; and if in the latter the 4 or 5 per cent. of carbon is combined with about 95 per cent. of the metal, we are possibly justified in inferring that a portion of the carbon in gray iron exists in one of the conditions before mentioned as probable.

From what is known of the Bessemer process it would appear that silicium is first oxidized in the process of conversion, and that its combustion produces a great elevation of temperature. If this be correct, considering the behaviour of white iron in the converter, it seems that not only the carbon, but the silicium too, is differently situated in white and gray pig iron in a state of fusion. An explanation of these various conditions and phenomena must at present be a matter of pure conjecture, as we are almost without information on this important point. When the combustion of the graphitic carbon commences, the heat rises rapidly, chemical affinity between the iron and its constituents is, so to speak, lessened, the oxygen of the air is at liberty to act with greater effect, the carbon which existed in the crude iron in the combined condition is burnt, last portions of silicium are oxidized out, and good malleable iron results. If, in the use of white iron, a temperature could once be obtained high enough to lessen to such an extent the affinity between the metal and its carbon as to allow the oxygen to take the latter, the conversion would succeed; but unless this elevated temperature could be imparted to it previous to its treatment with air in the converting vessel, its peculiar constitution renders this otherwise impossible. Lately in Styria and in certain parts of England, by a lengthened treatment in the "converter" with highly pressed air, pig irons resembling IV. (in the table) in composition, containing a small quantity of graphite, have been manufactured into an inferior kind of steel.

Chemists are generally of the opinion that the quality of Bessemer steel is strongly influenced by the amount of silicium contained in the raw iron from which it was derived, and Phipson* sought to prove that in pig irons which may be successfully used in the making of steel, the silicium must, like the carbon, exist in the free state. The means by which he arrived at this conclusion were somewhat peculiar, and Dr. Tosh made some experiments on the subject, an account of which were published.† Phipson examined three varieties of iron, A, B, and C, in which he found the silicium to exist as under :—

* Comptes Rendus, t. lx. p. 1030. † Chemical News. No. 330.

	A	B	C
Combined silicium, or Si a, . .	98	1·81	2·60
Graphitoidal silicium, or Si b, . .	3·22	2·14	1·63
	4·20	3·96	4·23

Because A contained its silicium principally in the free state, and C for the most part combined, they yielded respectively good and bad steels. In order to detect this graphitoidal silicium, Dr. Tosh dissolved about 20 grammes of iron (I in the table of analyses, which ranks highest among steel makers) in dilute hydrochloric acid, collected the insoluble matter, and burned it in oxygen. The residue was evaporated to dryness twice with hydrofluoric acid to remove silica, and afterwards heated with strong hydrochloric acid to remove a small quantity of oxide of iron. After this treatment a very small quantity of a light brown substance, which displayed none of the physical properties of graphitoidal silicium under the microscope, was obtained, but which proved to be titanic acid, so that free silicium could not have been present.

To estimate the two modifications of silicium, Dr. Phipson treated a weighed quantity of the iron with aqua regia; the resulting silica from Si a was dissolved by the acid, while that from Si b was insoluble. It is a well established scientific fact, that any variety of silicium which has once been exposed to a red heat (as Si b in iron must certainly have been) is quite unaffected by aqua regia—enough in itself to show how little this process is to be relied on.

To see if the amount of insoluble silica was a constant quantity, the following three experiments were made by Dr. Tosh:—

I. 2·409 grms. of iron dissolved in aqua regia ($3HCl + NO_6H$) gave 0·0565 grm. $SiO_2 = 1·094$ per cent. silicium.

II. 2·39575 grms. of iron in a large excess of aqua regia gave 0·038 grm. $SiO_2 = 0·74$ per cent. silicium.

III. 2·336 grms. of iron, dissolved in aqua regia, and most of the acid carefully boiled off before filtering gave 0·06775 grm. $SiO_2 = 1·353$ per cent. silicium.

As might be expected, the amount of insoluble silica varies with the quantity of acid employed; thus in II., where much acid was used, the quantity of silica is only about ½ of that in III., where, previous to filtration, most of the acid was boiled off.

Dr. Phipson * states that what he at first looked upon as free silicium in pig iron, occurred, he had more recently found, as silicic acid combined with protoxide of iron. Now if we are to consider the 3·22 of Si b (given in Dr. Phipson's estimations), as present in the state of silicic acid saturated with protoxide of iron, we arrive at the discovery that this iron contains 23·46 per cent. of slag. Few chemists would accept this statement without strong evidences of its truth. To ascertain whether this position were tenable, 3 to 4 grammes of Cleator iron (I.) were heated in a stream of perfectly dry chlorine; all iron and silicium are volatized as chlorides, while silica if present remains unaffected. The carbon burnt off in oxygen, a small residue was obtained, mostly titanic acid, weighing only 1 or 2 milligrammes, equal to 0·3 per cent., instead of 6 or 7 per cent., as Dr. Phipson would show.

From his experiments, by a course of reasoning upon which we have no enlightenment, Dr. Phipson infers that only Si a, and not Si b, exerts a deleterious action in the conversion of iron into steel. If, however, we have shown his assumption that Si b exists in pig iron is groundless, no correct conclusions can be drawn from the data which he has given, and until our information is more definite, the subject must remain where it is.

The presence of graphitoidal silicium in iron, though believed possible by many metallurgists, has so far never been clearly shown. Dr. Percy † thinks its existence highly probable, and Buchner ‡ makes a statement to the same effect, but neither seems to have made any special experiments on the subject. Hahn § prepared a silicide of iron containing as much as 20·29 per cent. silicium. By treatment of this substance with hydrofluoric acid, a small crystalline residue remained undissolved, which proved to be a definite compound $Fe\,Si_2$. Even with this enormous percentage of silicium none of that element separated in the free state. In the preparation of this compound only pure materials of known composition were used, and it may be urged that in the presence of the numerous substances which make up the constitution of crude iron, its behaviour might be modified. Caron * states that silicium never can exist in the uncombined state in iron, and that on account of its superior affinity it expels most other elements from combination.

As mentioned in the earlier part of this paper, the quantities of sulphur and phosphorus, particularly the latter, in iron, are not very materially lessened by its conversion into steel by the Bessemer process, hence only those varieties of crude iron can be used which contain an exceedingly small proportion of these elements. Numerous attempts have been made to remove these substances, and many patents have been taken out with the same object, but as yet none have been successful. Calvert recommended the use of common salt, but its volatility at the extraordinarily high temperature of the metal while undergoing decarburization was an impediment to its employment. Wintzer, a Hanoverian ironmaster, professes by the use of chloride of calcium to remove these objectionable substances; but, so far, he has failed to show any benefit by his process.

Sulphur, phosphorus, and silicium, in a specimen of steel made from Harrington pig iron (II. in the table), have been ascertained. The percentage in the iron and steel respectively are given below:—

	Iron.		Steel.
Sulphur, ...	0·075	.....	0·034
Phosphorus, ...	0·055	.....	0·046
Silicium, ...	2·286	.....	0·172

We have already observed that malleable bars made from hæmatite pig iron by the ordinary process of puddling, are so red-short as to be almost useless. A piece of this iron at a dull red heat is so brittle that it breaks into fragments after a few blows under the hammer. This property cannot in the present instance be ascribed, as it usually is, to the presence of an excessive quantity of sulphur, for even the raw hæmatite iron contains a less proportion of that element than the refined malleable bars of the best Swedish and English makes, such as Dannemora and Lowmoor; and it is very unlikely that the amount of sulphur should increase by puddling.

The Cumberland pig irons are as a class rich in silicium, and on the other hand contain very little manganese; and it is possible that these co-existing peculiarities of constitution point towards the cause of red-shortness in the present case. Caron † showed that at a high temperature in an oxidizing atmosphere, manganese possessed the power of removing silicium from iron. This property at once assigns to manganese a place of high importance in connection with many operations in the metallurgy of iron, particularly that of puddling. Until spiegeleisen began to be used in making Bessemer steel, and its beneficial influence forced itself to be recognized, the action of manganese was greatly ignored by many practical men, at least in Britain. Any literature we have on this subject is for the most part of an exceedingly vague description: the determination of manganese in iron by commercial analysts is often looked upon as a matter of minor importance; hence we have no good grounds to go upon in seeking to understand the action of this substance. It is, however, highly probable that in the removal of silicium by puddling, manganese plays a very important part; and looking upon the small proportion of this metal in hæmatite pig iron, in forcible contrast with the large amount of silicium, it is very possible that a comparatively large percentage of the latter element remains combined with the iron, exerting upon it a most deleterious effect, and causing the red-shortness in question.

Titanium exists in small quantities in hæmatite irons, very probably combined with cyanogen and nitrogen, forming cyano-nitride of titanium, the composition of which was first shown by the researches of Wöhler.‡ Although the effect of its presence in iron is not distinctly known, the prevailing opinion among chemists and metallurgists is, that the cyanogen compound being probably merely diffused through the metal, and not chemically combined with it, its influence is very small. In repairing the blast furnaces in the Cumberland district, very considerable quantities of this cyano-nitride of titanium are found in the vicinity of the hearths, generally in the irregularly shaped lumps which, though black and dull on the outside, exhibit when broken an exceedingly beautiful copper-coloured mass of crystals, among which a little iron is diffused. The crystals are octahedral. The faces of the crystals are rough and deeply striated, resembling occasionally the skeleton forms presented by common salt.

* Comptes Rendus, t. lxii. p. 803.
† Metall: Iron and Steel, p. 131.
‡ Journ. f. prakt. Chemie, bd. 72, p. 364.
§ Ann. d. Chem. u. Pharm, cxxix. p. 57.

* Memoire sur les Aciers.
† Memoire sur les Aciers.
‡ Ann. d. Chem. u. Pharm., lxxiii. p. 33.

The blast furnace slag has been examined for titanic acid, and found to contain a mere trace.

Nitrogen, as it occurs in iron, stands in close relation with titanium. According to Caron * it is to be found to a greater or less extent in all commercial iron, from which it can only with the greatest difficulty be perfectly removed.

A specimen of slag from one of the Cumberland blast furnaces, when analyzed, showed the following composition:—

		Oxygen.
Silica,	30·200	16·11
Alumina,	12·907	
Protoxide of iron,	1·269	
Lime,	50·507	21·58
Magnesia,	2·553	
Alkalies,	1·225	
Sulphide of calcium,	2·400	
Phosphoric acid,	trace.	
Titanic "	trace.	
Protoxide of manganese,	trace.	
	100·173	

The percentage of silica is strikingly low, and if it be calculated, it is found that the bases are very considerably in excess, the relation of oxygen being about 8 in silica to 10 in the bases.

We have often heard of the loss some of the companies in this district experience from the rapid wearing out of the furnace lining; sometimes after only three months' working, or even less, the firebricks were quite burned through. If the specimen analyzed represents the slags usually produced, and is not a very exceptionable case, this destruction of the furnace lining is easily explained, as Dr. Tosh thinks, thus:—"If unneutralized bases cannot find silicic acid in the ores to combine with, they will seek it elsewhere, and coming in contact with the firebrick lining will at once attack the silica in it, causing this disastrously rapid tear and wear of which I have heard so many complaints. In order to remedy this evil, furnace managers must either use less limestone or a larger quantity of siliceous matter.

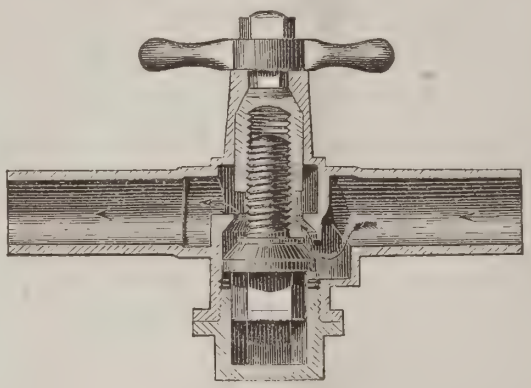
"This slag was of very vesicular and open structure, and of a grayish colour, agreeing closely with another described by Percy,† which he looked upon as a highly basic silicate, a conjecture fully confirmed by my analysis."

It is to be hoped that yet, in the resources of science, an economical method will be found for removing sulphur and phosphorus by some aid to the Bessemer process; for until that great discovery can be applied to the more strictly phosphoric ores of this country, its success can scarcely be considered complete, great as is the revolution it has already effected.—V.D.

MR. RICHARD HARRISON'S, OF DUBLIN, IMPROVEMENTS IN COCKS OR TAPS.

These improvements apply to cocks or taps, suitable either for steam, air, or gases under pressure; the object being to obtain a sufficient steam or fluid tight cock or tap, without the use of a stuffing-box or packing, as hitherto required for that purpose. The thoroughfare through the cock is closed by means of a valve resting upon a horizontal valve-seat, with a packing or facing of leather, in some cases applied either to the face of the valve or its seat; or the valve may be conical and fit a conical valve-seat, in which case all packing is dispensed with. This valve is opened and closed by means of a screw-spindle, which is either carried by the valve, and works inside a female screw, made in a conical cap rotated by the usual "crutch;" or the screw-spindle may engage with a female screw made in the centre of the valve itself, in which case the crutch for turning the screw-spindle is fitted directly thereon, and a conical portion or enlargement is formed in the upper part of the spindle, which is caused to fit accurately into the chamber of the tap or cock, which is also tapered or made conical to correspond to the said enlargement. The accurate fitting together of these two conical surfaces prevents any leakage from the cock, and obviates the necessity for the usual stuffing-box or packing. The valve itself is prevented from rotating whilst under the action of the screw-spindle, by having a square or other suitably shaped guiding stem formed in its under side, which engages into a corresponding chamber or recess in a hollow screwed cap, which closes the lower part of the body of the tap or cock.

We have no hesitation in stating that this tap or cock patented by Mr. R. Harrison is, for purposes of supply at high pressure, the very best that has come under our notice. It may, of course, be employed either as a crooked-nosed cock for directly drawing off water, or as a stop-cock for cutting off supply, &c. Constructively two forms of internal valve have been patented, viz., either with a conical seat, to which the conical valve is ground water-tight; or flat-faced, with a leather or vulcanized india-rubber elastic facing. In either form it is effective, and the construction possesses this salient advantage, that the force of the screw employed to close the valve acts in such a way as *not* to tend to force off the cap at either side of the tap which confines the water within it. This is the great defect of every tap analogous to these which we have previously seen. It will be remarked, when the valve, as in the fig.,



is drawn home to its seat and is shut, at which time whatever wear may have occurred might tend to cause leakage at the top ground cone, next the handle of the screw-spindle—that then the *water pressure is cut off* from all but the back of the valve, so that leakage above *then* is impossible; and, on the other hand, when the valve is open the above-mentioned cone is forced by the opening screw into close contact with its seat.—Ed.

* Memoire sur les Aciers.

† Metall: Iron and Steel, p. 506.

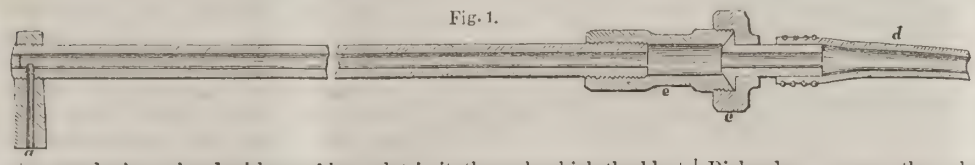
THE RICHARDSON PROCESS.

We turn to a consideration of what may be termed the history of the Richardson process up to the present time, a brief period of history most truly, still one in which some changes of importance have been worked out. In this, as is always the result in every novelty, there have been certain and special difficulties to contend against, for which no anteriorly existing experience was available, that pointed at once to a remedy. At first unpractical men declared that the furnace bottom would be oxidized away to the thinness of a nutshell in almost no time; we need hardly say that from the date when this notion was first promulgated, we showed direct reasons that the supposition was a myth which could not be realized.* The main difficulty has been with the rabbles. As at first made, these consisted of a malleable iron tapered slab with three holes in it, fixed on to the end of 1¼-inch gas-pipe, the holes entering the tube. The mode of construction itself was costly, for the reason that the slabs were first forged into shape and drilled at the upper end to receive the tubular handle; after which the diverging holes for the blast to escape into the metal had to be drilled. Great care was necessary with these rabbles that they were not kept in the furnace too long, as from the high temperature to which they were thus of necessity exposed, and the base of the instrument constituting a considerable surface, the jets of oxygen escaping at a high velocity round the sharp corners of the holes and across the horizontal surface, quickly ate away the metal forming the base of the implement; the pressure of the blast then used being probably sufficient to blow the liquid metal and the protective coating of tribasic silicate of protoxide of iron out of contact with those parts of the rabble from which the jets escaped, so that the waste of rabbles entailed a small though notable charge per ton of iron produced. The rabbles, as first used, are shown at figs. 1, 2, 3, and 4.

* Vide *Practical Mechanic's Journal*, p. 230, vol. iii. Third Series.

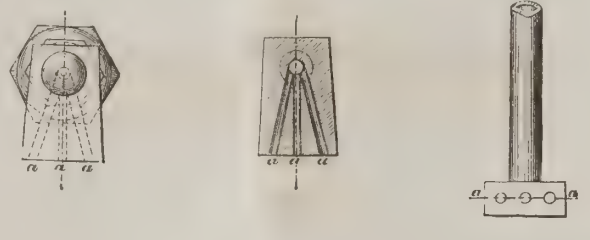
After the process had been in operation, and the little troubles connected with the durability of the rabbles showed themselves, their construction was simplified to that shown at figs. 5, 6, and 7, where the end is formed of two pieces of iron plate, which are united together by welding a strip of iron between the two opposite longitudinal edges,

Fig. 1.



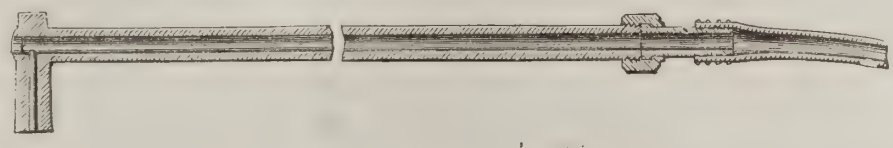
thus producing a head with an oblong slot in it, through which the blast escaped into the metal. The weight of iron in these heads was considerably less than in those first used; the metal being much thinner there was less surface at the base for the oxygen of the blast to attack, and these rabbles lasted much longer, although they by no means were so durable as could be desired. Further experiments gave new light,

Fig. 2. Fig. 3. Fig. 4.



until one day when an almost worn-out rabble was in the furnace, and the head either melted or broke off, the puddler continued the application of the blast with the mere tube which constituted the handle of what had been the hollow rabble. There being no more rabbles at hand at the time, the puddler continued to use the tube minus the rabbling head, the tube being afterwards bent over as shown

Fig. 5.



in fig. 8, the result of which was to point out that the mere tube was much more durable in the furnace than the implements previously used had been; but with the bent tube the men found that they could not work or rabble the iron about, so it became necessary to combine something with the very durable tube, which would enable the rabbling as well as the diffusion of blast to be effected simultaneously.

Fig. 6.

Fig. 7.

It was further found that the diffusion of blast was rendered more perfect when the instrument was held in such position that the jet issued horizontally through the fluid metal, in place of vertically downwards into it, as with the two first used rabbles. The instrument now used is of the form shown at figs. 9 and 10, consisting of a mere bent tube with a projecting rabbling piece welded on to it; the durability of this instrument is exceedingly great, and it costs no more than the common solid rabble employed under the old system of puddling.

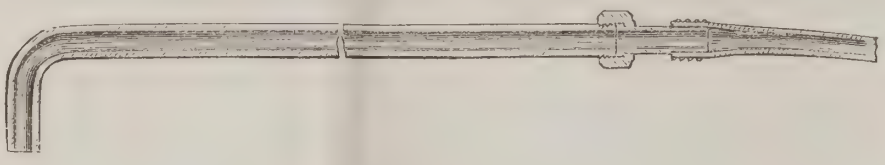
Another slight difficulty that has been met with is the little less durability of the roofs. The higher heat produced by this process melts them away more rapidly; but this is a drawback which has frequently before been experienced in other metallurgic processes, and easily overcome. In certain new processes for manufacturing steel, the Martin process, for example, the high temperature there used acted severely on the roof, as well as in the case of Mr. Siemens' earlier furnaces; but in such cases this at first apparent defect has been successfully set aside by the introduction of a roof a few inches higher, and formed of better bricks. It is well known by those persons who are acquainted with the materials of furnace construction, that for puddling furnaces wherein the temperature does not reach anything like the higher limit employed in certain other metallurgic operations, inferior and soft bricks are supplied; whereas for furnaces wherein higher temperatures are necessary the harder and more durable bricks are retained. Better bricks, in conjunction with a higher roof, will unquestionably remove the roof difficulty. We, however, do not expect that ironmasters will readily consent to make alterations in the roofs—in cases where they do not a resort to the other cure will suffice. But in these final experiments with the Richardson process there has been another influence at work, which does not occur to such an exceeding degree in any other operation affecting the chemistry of *iron metallurgy* with which we are acquainted; that influence consists in the high pressure of blast that was for some time employed. In the first experiments made at the Glasgow Iron Works in the month of August last, the blast pressure reached a mean of 4 lbs. per square inch, it not being possible to obtain a higher blast with the blowing engine at those works. The case, however, was different with Mr. Kirk's engine,* put down at Parkhead for supplying the blast there required for the Richardson process; this engine was at first run at 130 revolutions per minute, which gave a pressure of 15 lbs. per square inch, but this, by the time it reached the mouth of the rabble, was reduced through turning corners in the blast mains, and through friction in the pipes, to about 12 lbs. The higher pressure was adopted, because it was supposed by Mr. Richardson, as well as by the writer of this paper, that that pressure of blast would be more effectual in desilicating the iron, as it had been found to do in the Bessemer converter. However, a puddling furnace and a converter are two totally different structures. Whereas one is adapted for refractory resistance to the highest temperatures we can employ in metallurgic operations connected with iron, the other is not; the consequence being, that an exalted blast pressure simply became a measure in terms of itself of the durability of the puddling furnace roof. The experience of a system of practical trial of sometimes success and sometimes failure of this nature soon pointed the direct road to a remedy; from 15, the pressure at which the safety valve was formerly weighted to blow off, this was reduced to 12, 10, 9, 8, 7, 6, 5, 4, and, whilst we write, to 3 lbs. per square inch in the receiver; this when diminished by the retarding effect due to passing curvatures in the blast main, would correspond to a less blast pressure than 3 lbs. at the escaping mouth of the rabble, supposing the escaping temperature of the blast the same as in the receiver. However, it is extremely likely that the velocity of escape of the blast is above that due to the mean blast pressure in the receiver, on account of the great accession to its volume which must occur as it approaches the escaping end of the rabble, which being raised to a temperature although many degrees less than that of the furnace proper, must expand the blast in a considerable ratio above that due to its original compression. Although we have felt called upon to throw out these inferences, for the simple reason that we aim at completing each point that turns up in the discussion of this most interesting and important metallurgic process, still we wish to explain that, whereas this large accession to the original volume of the blast due to its initial compression does obtain, still the quantity or rather weight of that element which effects the perfect decarburization and desilicatization of the iron, namely, oxygen, is not increased, but merely escapes through the fluid iron at a higher velocity (on account of its expansion) than that due to the receiver pressure. With the low blast pressure lately employed the temperature of the furnace is necessarily lower, and the roofs do not appear to be affected by it any more than by the ordinary mode of puddling.

A full *resumé* of this process was brought before the Institution of Engineers in Scotland, on Wednesday the 15th ult., by Mr. St. John Vincent Day, C.E., who has been connected with it from its very earliest date, and who produced samples of the iron that had been manufactured by the process. It is almost needless for us here to speak of the exceedingly high quality of the specimens he produced; puddled or mill-bars were shown fully equal to some high-class brands of reheated and

* This engine is described and illustrated at page 336–37 of the present number.

finished iron. We shall not further allude to this paper at present, as we intend to publish it *in extenso* in succeeding parts of this journal. The purity of the iron, as we have before shown,* is especially remarkable, and its modulus of resistance to rupture is very high also; but on this point, as there have been but very few experiments made, we rather prefer holding partial reticence as to exact values until another occasion. Suffice it now to say that the mechanical properties show themselves much higher than those which result from tests made with iron produced from the same pig iron by the ordinary method of puddling.

Fig. 8.



In how valuable a light the process is received may be best judged of from the fact of the number of applications that have been received by Mr. Richardson for the working of the process in foreign countries, and these continue to be made.

The prophecies of those far-seers, who declared that the cast-iron bottoms would not stand the oxidizing effect of the blast, have subsided to the natural level of chimeræ of the past, as such hazarded opinions always do; and the effect in this particular respect has been exactly zero, as we foretold it would,† basing our argument upon the true facts bearing upon the chemistry of the case, and on no other *quasi* consideration.

Fig 9.

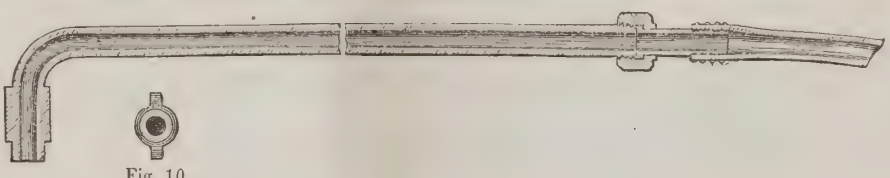


Fig. 10.

Ere concluding this paper one other point crops itself out of the numerous others which naturally suggest themselves to the metallurgist —this being the probable effect that the Richardson process will produce upon the material imported into this country, for the manufacture of steel by cementation (what is commercially known as blister steel). The manufacture of blister steel, however, is one that will probably by-and-bye die out, when the great process of Bessemer is so far perfected (for we are decidedly amongst those who believe it will be) to enable the production from the converter of all those varieties of steel now used, and many others too, for purposes yet doubtless not as much as thought of. However, there are grave reasons for still believing that that millennium of the universal manufacture of steel from the converter, is yet at a remote distance; and until the existing difficulties which we have alluded to in previous papers are overcome, the supply of blister steel must of necessity continue. Swedish iron is the material now chiefly employed for the manufacture of steel by cementation, and it is used simply because we have never yet been able to obtain British-produced iron sufficiently free from impurity. For the cementation process now, however, Richardson's method of manufacture promises much, as we can from the commonest pig iron of this country produce bars for cementing into blister steel far purer than any Swedish, or indeed other bars, yet recorded to have been imported. For the manufacturers of blister steel (as long as that manufacture may last) the Richardson process promises to effect economy in the first cost of what is to them their raw material; and if we may legitimately value that compound in terms of purity of iron in combination with carbon and infinitesimally minute percentages of the common impurities, even in this respect, also, the Richardson process may hopefully be looked upon as capable of producing a better material than heretofore.—V. D.

* Vide *Practical Mechanic's Journal*, p. 230, vol. iii. Third Series.
† Vide *Practical Mechanic's Journal*, p. 230, vol. iii. Third Series.

COIN AND COINING.

By Joseph Newton, Mechanical Engineer, Royal Mint.

(*Continued from page* 266.)

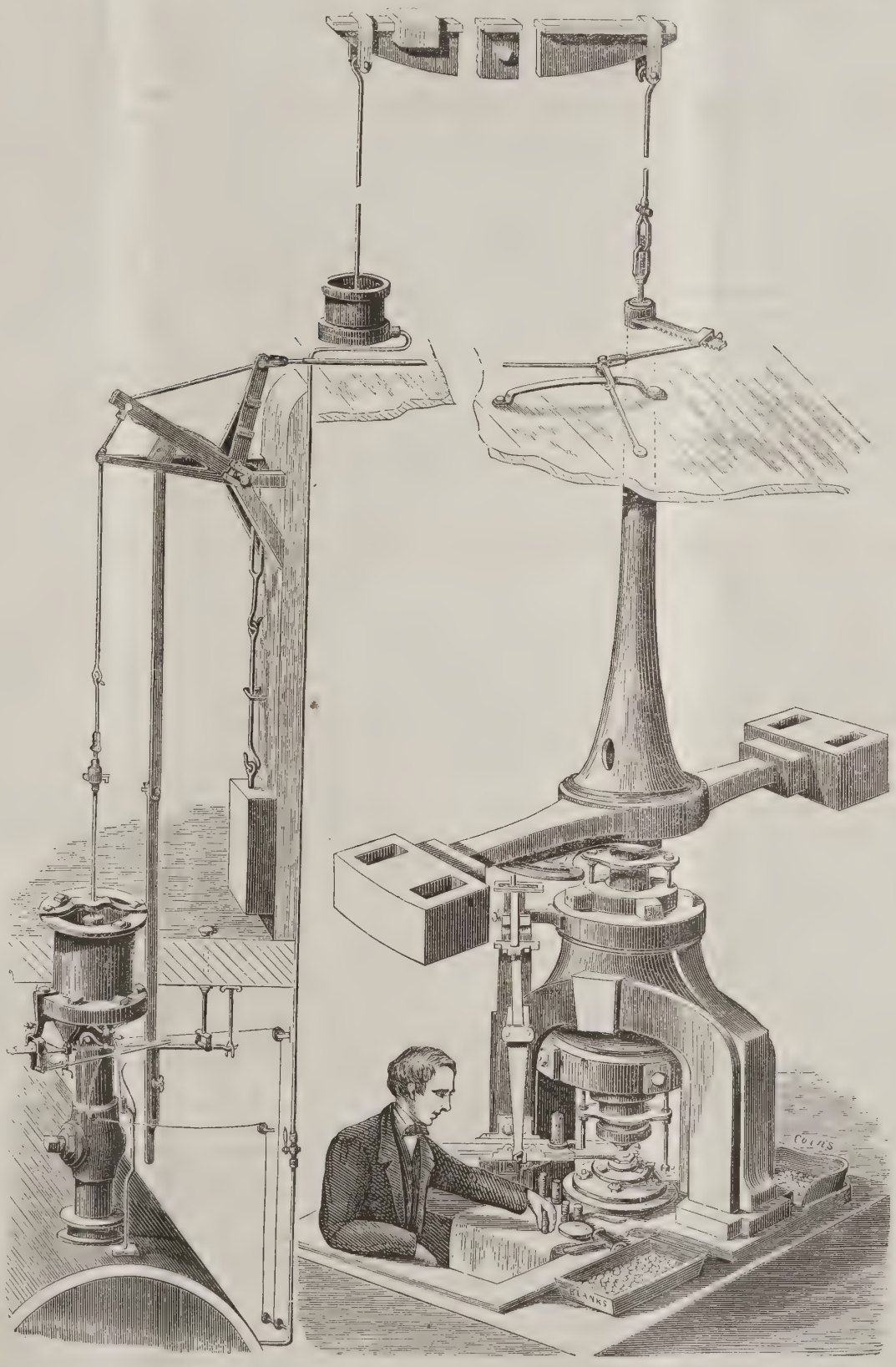
The small bags into which the planchets are put are now advanced to the next and, in a mechanical sense, the finishing department of the establishment, the *Coining Press-room.* Here they (the planchets) are once again weighed, and again the tickets are marked with the exact weight of each journey. While this operation is in progress we may take a glance at the apartment and its appliances. The former is of noble proportions, being 70 feet in length, 30 feet in width, and 18 feet in height. Two row of square oaken columns of massive dimensions, and at intervals of 7 feet, extend from an iron-faced platform to the cross-girders which support an upper floor. Nine of these columns are ranged on either side of the room, and they are connected in pairs transversely by cross-bars of iron. Upon the platform, whose base is of stone, and in line along its centre, are ranged eight coining presses. These are ponderous machines, and they are securely bolted down upon granite beds. Upright hollow shafts of cast iron, the lower ends of which expand in trumpet form, and rest upon the fly-arms of the presses, pass through guiding brasses to the floor above, and are the media for the conveyance of motion to the presses. Each press has a coarsely pitched three-threaded screw of wrought iron passed vertically through a gun-metal bush or nut in its centre. The central screw in a stamping press of the peculiar construction of those at the Mint, is the very heart of the machine; as the fly-arms vibrate the screw rises and falls, and with it the die which imprints the planchet.* Each screw passes vertically through the body of the press, and projects below the nut or bush to the extent of 7 or 8 inches. A hardened steel block is sunk into its lower end, whilst the upper part, of a tapering form, supports the fly-arms and the trumpet shaft. Steadying brasses and set screws keep it from shaking in its upward and downward movements. Between the lower end of the main screw and the planed surface of the bed of the press, which latter is 15 inches in thickness, and forms the anvil block upon which the coins are struck, the upper and lower die-holders are affixed. The upper die-holder is supported by two chariot rods, working through holes made in the body of the press for their reception, and are fastened to a collar which rises and falls with the main screw: the upper die-holder is furnished with a disc of hardened and polished steel, which the chariot rods are made to bring into contact with the steel toe of the screw. The chariot rods have also sliding guides to keep them and the die-holder in their proper positions as they move upward and downward.

It will now be understood that the arrangement is complete for the ready attachment by aid of set screws of a die, either obverse or reverse as may be determined. Firmly screwed down on the bed of the press is the lower die-holder. In "setting" dies for stamping, it is essential to place the lower one truly or precisely below that in the upper die-holder. The engraved surface of the one die thus faces that of the other, and it is only necessary to interpose a soft piece of metal between the two and squeeze it between them to produce a coin. The circularity of the latter is preserved by surrounding it with a steel collar at the moment of impact.

It has been thought desirable, for the better elucidation of the subject, to give this general idea of the screw press before advancing to a detailed account of its action. The reader will perhaps not object to being kept waiting for a short time further before returning to the golden blanks of which we have for the present lost sight. The interval shall be occupied in explaining the pneumatic apparatus by which motion is given to the presses. It is not generally known that the atmosphere is enlisted into the service of her Majesty's money-makers, and made to stamp all her Majesty's coins; but such is the case.

* Lever presses are now much employed in foreign and newly-erected mints, but the writer is of opinion that the screw principle is the better one.

The pneumatic machinery of the Mint was originally invented and constructed by Messrs. Boulton & Watt in 1809. That eminent firm had determined, after many experiments at the old copper Mint at Soho, that the atmosphere, under proper conditions and control, was the best possible agent for the striking of coins. In order to employ it at Tower Hill they constructed a 10 horse-power steam-engine, together with two large air pumps for exhausting a vacuum chamber, which latter formed, and does form at present, a very important part of the pneumatic



arrangement. The pumps were placed vertically below a beam, which was made to rock by means of a crank attached to the fly-wheel shaft of the engine. The cylinders of the pumps were open to the air at the top, and below the pistons were circular valves opening inward to the cylinders. The pistons were packed with leather, and each had a pair of butterfly valves opening upwards. Below the cylinders, and connecting them with the vacuum chamber, were two iron pipes. The chamber itself is a cast-iron tube 60 feet in length and 3 feet in

diameter. It lies along the floor at the back of the coining press-room, and parallel to the line of presses.

The extent of the vacuum created within the chamber was regulated by a valve fitted with a steel-yard lever and shifting weight. A barometer, attached also to the chamber, exhibited in inches of mercury the amount of atmospheric pressure on its interior surface, or, in other words, the extent of approach to a perfect vaccum. These last arrangements remain in use at present, but the mode of exhaustion has been changed. In 1852 the writer of these papers was fortunate enough to devise a double-acting air-pump of peculiar construction, which, working at a distance of 150 feet from the vacuum chamber, exhausts it more effectually than by the old plan, and has saved the country £200 a year from the date named. Virtue, it is said, is its own reward, and the same remark applies to inventive skill in this instance.

The "Newton air-pump," as it has been termed by some, is of sufficient area to give greater power of exhaustion than the two pumps of Boulton & Watt. The piston is solid, but is encompassed by expanding rings of cast iron, as in that of a steam-engine. The cylinder has a hollow case or box above and below it, and in these are seated the valves. These latter are very small in size, but large in number. They are simply composed of saw-plate steel. Each valve-box contains sixty-four spring valves, thirty-two at each end of the cylinder. One half of them in each case open into the cylinder, and the other half into the discharge pipe. The exhaustion therefore proceeds both in the up and the down stroke of the piston. The communication with the vacuum chamber is made by means of a pipe carried over the roof of the coining department.

Let us now proceed to examine the mode of applying the power, gained by the creation of a vacuum, to the purpose of coining. Every press is supplied with two subsidiary pumps, connected with the vacuum chamber by means of pipes. Both pumps are open-topped and have pistons upon which the atmospheric column presses, when required, with the necessary force for effecting their respective purposes. In order, however, to make those purposes more readily intelligible, an illustration in perspective is annexed, of a Screw-coining Press with its Pneumatic Gear, as used at the Royal Mint.

In order to compress the drawing within the prescribed limits, it has been found requisite to introduce breaks in its continuity; the relative positions of all the details have, nevertheless, been preserved, and the connection between the vacuum chamber and the press will be readily comprehended. It will be seen that an iron rod passes through the trumpet shaft, and is attached to a rocking beam above it. The beam is poised on knife edges sustained on brackets, not shown in the drawing, and the lower end of the rod is affixed to the main screw of the press below. From the opposite end of the beam a rod descends to the piston of the upper pump, and below the piston is a small pipe running down to the vacuum chamber—shown in partial section at the foot of the illustration—and into which it passes. Thus when the air pump is in action a permanent vacuum exists in the upper pump, and the air presses upon the piston with just sufficient force to balance the main screw and fly-arms of the press, and sustain them in equilibrium. This circumstance is of great value, for it enables the attendant to move the press screw upward or downward with the greatest ease, and thus to facilitate the dies and feeding apparatus; the balance pump, in fact, gives life, so to speak, to the stamping machine.

Attached to the top of the trumpet-shaped shaft are a lever and two socket-ended rods working freely on steel pins. These form the direct agents for forcing down the press screw, and causing the die to impinge upon the planchet. A horizontal rod, stretched along the floor, is connected to a horse-head crank, and from this depends another rod which is hooked on to the piston of the lower pump. The pump itself is supported by girders immediately over the vacuum chamber, and between it and the latter are a communicating pipe and stop-cock. In the base of the cylinder of the pump are two small disc valves, one opening outward to the air, and the other serving to open and shut alternately the communication between the cylinder and chamber. A number of levers, springs, and rods, serve, with the aid of two tappets, for closing and opening the valves. To the valve-levers are attached starting and stopping lines, which are under the control of the workman who is the press tender. A rod depending from the horse-head crank carries the valve tappets, and a counterpoise weight balances the piston.

Thus, then, it is hoped a tolerably clear notion has been conveyed of the pneumatic contrivances of the Mint, and we can return to the press-room and the planchets of gold, which have been too long out of sight. Some of these, as it will be seen above, have been apportioned out to the youth who patiently sits in a recess of the press platform and awaits our coming. From a tray beside him he has taken a number of pieces and piled them in columns. This is preparatory to putting them into the feeding tube of the press, which is a brass receptacle holding several hundreds at a time. Having filled this and caused a pair of flattened forceps to clasp the lowest planchet and advance it to the face of the lower die, say the obverse, all is ready for action. The press has been raised to the extent of its travel, and with it the piston of the lower or striking pump. The forceps are caught within the prongs of a rod turning on a pivot, and will presently be moved towards, and carried back from the die, by means of a quadrant under the fly-arms.

Now, let it be observed, the dies are in their places, and are prepared to imprint on plastic metal copies in relief of their own *intaglio* engraven surfaces, as rapidly as they can be fed with the precious material. The press attendant pulls a line gently, and attaches it by a loop to a stud in the press-hole. This has allowed a spring to close the outside valve of the striking pump. A sharp tug at the other opens the inside valve, the air is exhausted from the cylinder, the piston falls in vacuum, the press-screw and upper die obey their master, and the planchet forcibly receives at once from the upper and lower die faces two very perfect, lasting, and beautiful impressions. More than this, however, has been accomplished at one blow; the edge of the piece has been indented, or milled, into the bargain. At the very instant that the upper die was descending, a milled steel collar, supported on a tripod spring, was raised above the face of the lower die, and thus formed a mould for the edge of the coin round its outer circumference. The transformation from absolute plainness to artistic finish was thus accomplished by a single touch!

While this operation was proceeding the forceps, which released at the right time and place the first blank, have returned to the bottom of the feeding cylinder for a second. In advancing with this, the milled collar having been pressed down again out of the way, it pushes the completed sovereign rudely into a catch-pan, and deposits the next candidate on the die. Again the upper die descends, another blow is struck, and another coin is made. The machine is now in full swing; the blanks sink in the feeding tube, the boy replenishes it, the forceps advance and recede, the collar rises and falls, the coined pieces of money are tumbling into the catch-pan, and at the rate of sixty coins per minute the press is adding to the gold currency of Great Britain!

The releasing of the catch-line, by preventing the formation of a vacuum in the striking cylinder, brings all to a stand still again when wanted, and permits the changing of dies and the making of re-adjustments.

(*To be continued.*)

PARSONS' PATENT BOLTS, &c.

Mr. Parsons' patent bolts, of which the following good description is taken from the *Engineer*, are avowedly designed for fish-plate bolts, but we strongly suspect have a side eye mainly to their adaptation to bolts for fastening on armour plate to the backing, and to take the wind out of Major Pallisser's sails by gaining elasticity (as is supposed, in reality uniformity of strength) without the projecting thread proposed by the latter gentleman.

For steady strains, Mr. Parsons' bolts will no doubt answer their purpose, bating always questions of cost of manufacture; but for impulsive strains such as those to which armour-plate fastenings are exposed these forms of bolts are utterly valueless. Mr. Parsons obviously is innocent of any precise knowledge as to the nature of vibratory or wave force transmission in solids, and therefore does not see that mere uniformity of section will not prevent a bolt being suddenly chucked asunder by an impulsive pull, though less than that of its half statical tension, for that any *abrupt changes in form* will prove as fatal to the bolt as sudden change in cross section within certain limits. To enter at length into why this is so, we cannot undertake here. Simple methods exist already for locking fish bolts so as to make them quite secure; for this end, therefore, Mr. Parsons' bolts are needless, for armour-plate bolts they are useless.

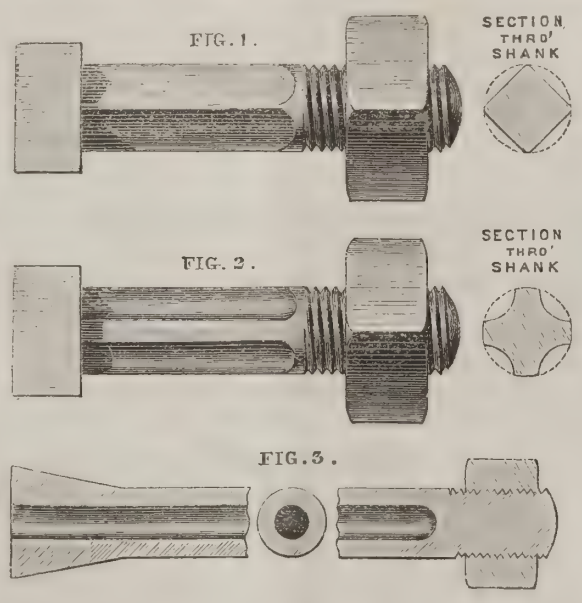
Major Pallisser's so-called *invention* of armour-plate bolts with the thread in relief, out of which he has made with such pertinacity and skill such excellent capital, was no invention at all, nor would have ever

been thought one for five minutes outside of the War Office and Woolwich. There is not a skilled mechanic in the three kingdoms that had not employed such bolts whenever safety against suddenly applied or uncertain strains demanded their use. We could point to dozens of examples of a quarter of a century old, or older. Mr. Parsons' patent bolts will, however, never supersede for armour the plain full thread bolt; nor, indeed, do we think them likely ever to be employed for bridges, roofs, &c., as contemplated by the patentee.

To find a simple and efficient method of preventing the loosening of the nuts of the fish bolts used on railways is a problem that many have attempted to solve, but we are not aware that as yet any of the various devices for that purpose have come into use, and railway engineers are fain to rely upon a daily examination and tightening up of the loose nuts by the platelayers on the line. No doubt this examination would in any case have to be made, however secure the fastenings, but there is a great difference in the time expended in simply walking over a line and observing if any of the nuts are loose, which is at once revealed by their position, and stopping, perhaps at every other joint, to tighten some of them up; this, coupled with the greater safety and ease in travelling, the reduction in the wear and tear of the rolling stock, and the cost of maintenance of the line generally when the nuts are always tight and the joints in good order, instead of a considerable portion of the time loose, is sufficient to account for the desire evinced by railway engineers to find a sure and simple method of effecting the object, as well as the numerous attempts made to obtain so great a desideratum.

All the plans that have hitherto been proposed resemble each other in principle in that they seek to avoid the defect by some mechanical contrivance applied directly to the nut to arrest its turning; none of them are directed to the root of the evil, and attempt to obviate the tendency itself of the nut to unscrew. The plan which we now present to our readers differs from previous ones in this respect, its object being to remove the cause instead of attempting to oppose the effect, so that when the nut is once fairly tightened up it will remain so without extraneous aid.

If we take an ordinary fishing bolt, say of $\frac{7}{8}$ inch diameter, tapped with a Whitworth thread, we shall find that the cross sectional area through the shank is just half as much again as the area through the



screwed part to the bottom of the thread. When a bolt thus made is subjected to strain, so long as that strain is confined well within the elastic limit of the metal, the shank and screwed part each stretch nearly in the inverse proportion of their respective areas and in direct proportions to their lengths, but the smaller area through the two or three threads of the screw left inside the nut for clearance where the greatest elongation occurs, having no appreciable length, the amount of elasticity given out by the bolt is very small—in an ordinary bolt 3 inches between the head and face of the nut, with a strain of 10 tons per square inch through the screwed part, it would not exceed ·0015 of an inch with iron of the best quality; it can easily be understood then that as so small a variation in the space between the head and nut makes the difference between a loose nut and a tension 10 tons per square inch on the bolt, how likely it is for the nuts of fishing bolts to be overscrewed, or to become loose; for a layer of rust, the scale of the iron, the necessary imperfection in the fit of the parts, would any of them absorb more than this amount, so that although a bolt may at first be fairly screwed up, after the passage of a few trains, having so small a range of elasticity, it soon becomes loose.

We have been supposing in this case that the nut has been so carefully screwed up as not to have strained the metal of the bolt beyond its elastic limit, but the fact is, in practice, with the rough manner in which the screwing is necessarily done, the severe and sudden strains to which the bolts are constantly subjected from heavy weights passing at high speeds, subsidence of the sleepers, unequal support, and twisting of the rails, and from the imperfections in the bolts themselves, and the fit of the parts, it is rarely the case that the bolt is not before long strained beyond its elastic limit. When it is considered that the fiftieth part of a turn of the nut is sufficient to absorb all the elasticity the bolt is capable of giving out, it would seem that such must ordinarily be the case, and to this we believe may be attributed the chief cause of the loosening of the nuts; and it is when this is about to occur that the inability of the ordinary bolts to prevent it becomes apparent. Suppose, for instance, that the screwed part of the bolt has, from overscrewing up, or any of the before-named causes, a tension of 20 tons per square inch put on it, this will strain the shank to about 13 tons per square inch, but then the relative stretch of the parts will no longer be in the inverse proportion of their respective areas, for the screwed part, being strained considerably beyond its elastic limit, will stretch nearly twenty times as much as the shank, take a permanent set, and thus distort the thread of the screw in front of the nut where the stretch takes place, so that the nut can only be screwed on further by its thread cutting into that of the bolt; thus the fit between the two is destroyed, a kind of shoulder is formed in the thread, making a seat for the nut at the position the nut occupied when the bolt was first strained beyond its elastic limit, and to this position the nut will always have a tendency to return, however frequently and tightly it may be forced up. Such, at least, is the solution of the problem offered by Mr. Parsons, and to remedy these defects he proposes to make the shank of the bolt of a different form in cross section from the screwed part, so that while a sufficient portion of the perimeter of the shank may be of the same diameter as the screwed portion of the bolt measured to the top or outside of the thread, and thus fit fairly into a hole that the screwed part of the bolt can pass through, the area of the cross section through the shank may be the same as the area of the screwed part measured to the bottom of the thread.

Various forms in cross section may be given to the shank to satisfy these conditions, depending on the depth of the thread and the amount of surface it may be requisite to retain on the perimeter, &c. For ordinary fishing bolts with the standard Whitworth thread the shank may be made square, as shown in fig. 1 of the accompanying illustration. Thus for a $\frac{7}{8}$ inch bolt the shank is made ·65 inch across the sides of the square, and the angles being taken off to the same diameter as the outside of the screw, leaves a bearing surface of about $\frac{1}{16}$ inch in width on each corner, which will generally be sufficient to maintain the true position of the bolt and fishing plates; but if more surface is required, or the thread is deeper, the form shown in fig. 2 may be employed.

It is claimed by Mr. Parsons that bolts thus made, while they possess all the requisite properties of ordinary bolts in maintaining the parts of a structure in their true position sideways, are entirely free from the defects inherent to ordinary bolts before explained; thus, as the cross sectional area of the metal is the same through the whole length of the shank as through the smallest area of the screwed part, the bolt is of equal strength and stretches equally throughout its whole length, so that not only has the bolt a greater useful range of elasticity, but the probability of the elastic limit being exceeded and the thread being distorted by overscrewing up or any sudden strain is avoided. This may be thus exemplified:—If we take an ordinary bolt and interpose a perfectly unyielding substance between the head and nut, only just touching them, the surfaces being perfectly flat and true, it will be found that about the twentieth part of a turn of the nut will be sufficient to put on a strain of 20 tons to the square inch through the bottom of the thread, and the metal at that part will then be strained beyond its elastic limit,

and will take a permanent set, whereas with Mr. Parsons' bolts it will require about six-tenths of a turn, or from ten to twelve times as much, to produce a like effect. Of course in practice the parts held together yield to the pressure of the bolt at first, and are not perfectly flat and true, and therefore the actual amount of turn necessary to tighten up the nut considerably exceeds the amount; but supposing the nut in both cases fairly screwed up to its bearing, then the nut of the Parsons' bolt would require ten times as much turning as that of the ordinary bolt, or any sudden strain brought upon it would have to be exerted through ten times the distance to strain it beyond its elastic limit. Thus by reason of the greater range of elasticity in the Parsons' bolt a steady pressure is always maintained against the force of the nut, and so long as this exists the adhesion between the surfaces is—it is claimed by the inventor—sufficient to prevent its getting loose, while the fit of the nut not being destroyed by a distortion of the thread, there will be no tendency of the nut to resume its old position, when from the unavoidable wear and abrasion of the surfaces tightening becomes necessary.

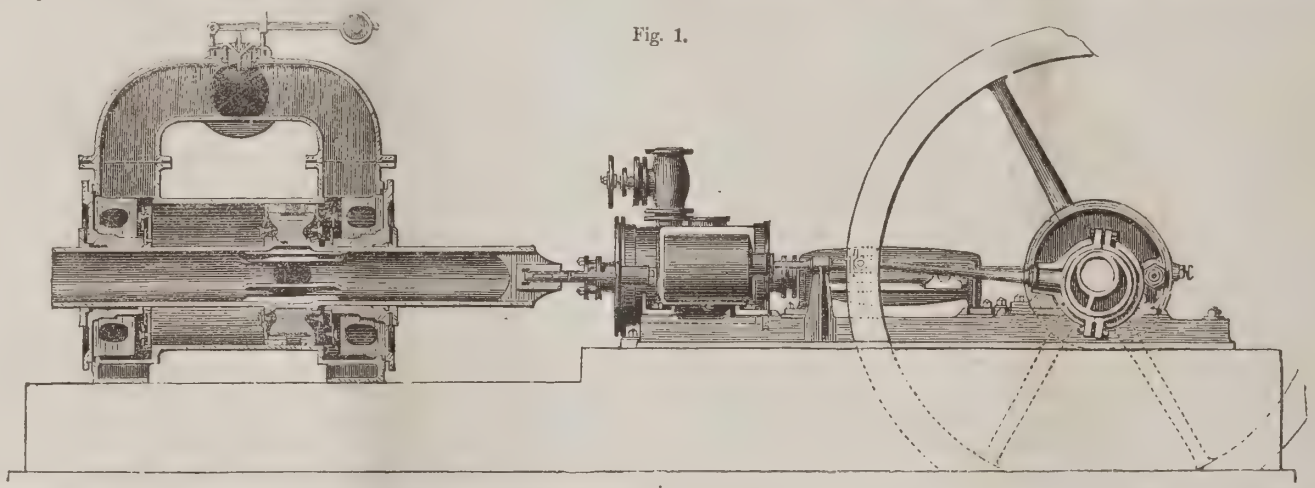
These bolts are now under trial on several of the principal railways, we understand, with every indication of confirming in practice the views held by the inventor.

Although these bolts are peculiarly adapted for securing fishing plates Mr. Parsons also contemplates their employment for various other purposes, particularly when sudden strains and vibrations occur; when experiment has demonstrated that he is right in his conclusions they will no doubt be found superior to ordinary bolts for connecting the parts of iron bridges, roofs, and other similar structures, as well as for fastening armour plates to forts and vessels. For this purpose, as the weights to be sustained by the bolt sideways is great, if more surface is required than afforded by the form shown at fig. 2, it may be obtained by adopting the plan shown at fig. 3. In this the full external diameter of the bolt is retained throughout, and it is made tubular up to within a short distance of the thread of the screw, the inner diameter being so regulated with reference to the depth of the thread as to make the area of the cross section at this part the same as the area of the screwed part to the bottom of the thread.

THE BLOWING ENGINE AT PARKHEAD FORGE.

THE engine forming the subject of the present notice was put down a few months ago for producing the blast required in connection with the

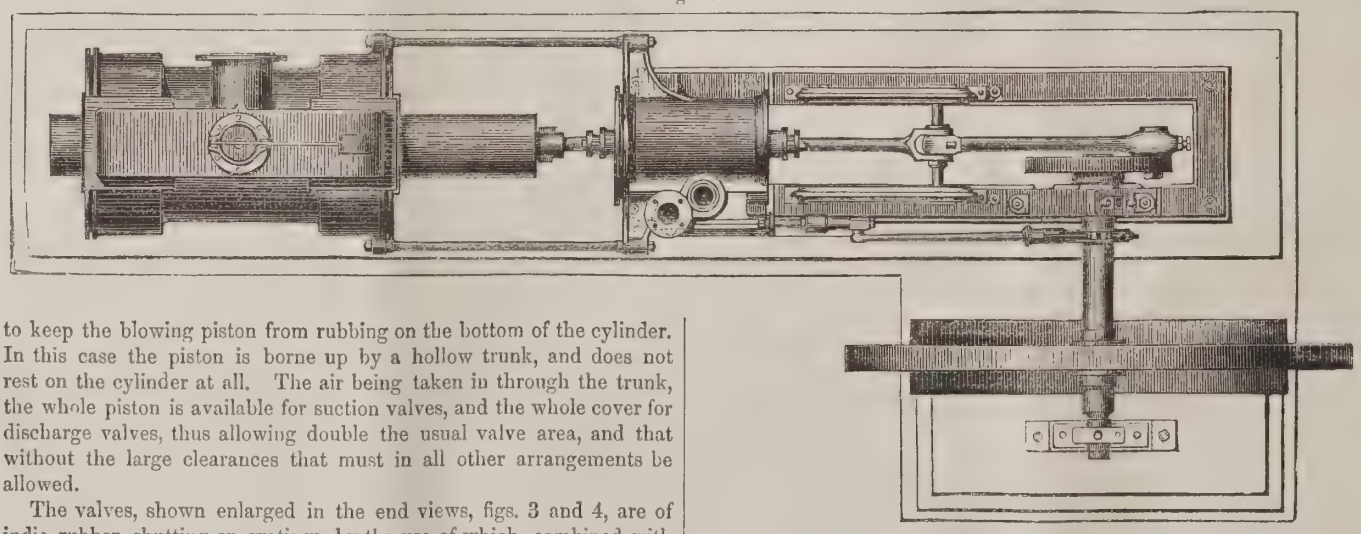
Fig. 1.



Richardson process. Fig. 1 of the engravings is a longitudinal section, and fig. 2 a plan showing the arrangement of engine and blowing cylinder; the woodcuts being prepared from tracings supplied for the purpose by the patentee, Mr. A. C. Kirk, of Messrs. James Aitken & Co., Glasgow, and under whose direction the engine was constructed.

In all attempts at a horizontal blowing engine the difficulty has been

Fig. 2.



to keep the blowing piston from rubbing on the bottom of the cylinder. In this case the piston is borne up by a hollow trunk, and does not rest on the cylinder at all. The air being taken in through the trunk, the whole piston is available for suction valves, and the whole cover for discharge valves, thus allowing double the usual valve area, and that without the large clearances that must in all other arrangements be allowed.

The valves, shown enlarged in the end views, figs. 3 and 4, are of india-rubber, shutting on gratings, by the use of which, combined with the large area through the valves, a high speed can be used; the engine under consideration having worked quite quietly when blowing under 15 lbs. per square inch pressure at 120 revolutions per minute.

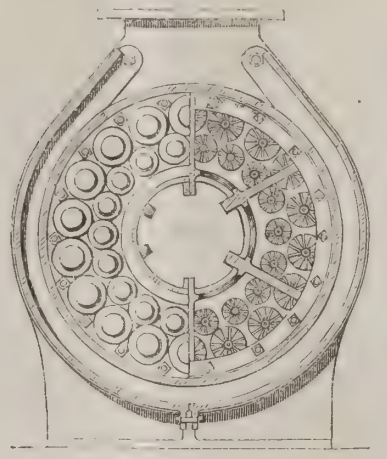
In large machines of this kind large guides are provided, by which each end of the trunk may be more completely supported, and the valves may be of either leather or india-rubber.

The cylinder is surrounded by a water-jacket, which has been omitted for clearness. It was at first thought that a higher pressure, above that which is now used for the Richardson process, would be requisite, and on that account the engine was constructed to work at a high speed, so that the space for the water-jacket in that case might have been necessary; still, with the lower pressure which practice has shown most advantageous for the process, the employment of the cooling jacket is dispensed with.

We have examined the engine on several occasions, and have no hesitation in pronouncing it a most perfect horizontal blowing machine.

It will be apparent to every practical engineer that the use of the hollow trunk in the blowing cylinder affords great facilities for the

Fig. 3.



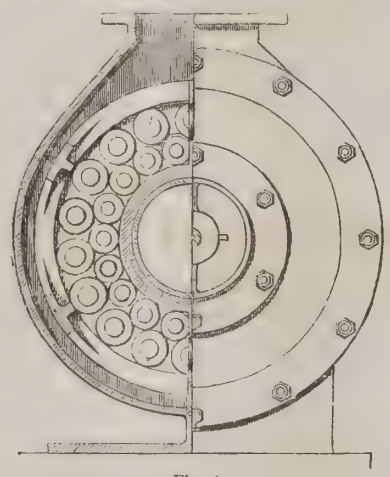


Fig. 4.

admission and egress of the blast, simplifying very much the construction of the blowing cylinder itself, through dispensing with the ordinary valve boxes.—V. D.

KIDD'S PATENT SAFETY APPARATUS FOR PREVENTING THE BURSTING OF WATER PIPES BY PRESSURE OR FROST.

THE action of this apparatus is twofold—1st, to cut off the supply where it enters the house as soon as the house cisterns are full; and 2nd, to keep the pipes always empty, except when the water is actually running in them. It is equally available whether the water supply is constant or intermittent, but can only be used when the water for the upper stories of the house is delivered into a cistern, and drawn from this as required. In the kitchen, or basement story, the supply can be taken direct from the main. In the following description we shall suppose the supply to be constant.

Two cocks, A and B, are placed on the supply main, C, as near as may be to where it enters the house, and these cocks are connected with floats, A x and B x, in a small cistern or tank, D, placed underneath them; into this tank the overflow, or notice pipe, E, from the highest cistern in the house is conducted. As soon as the house cistern is full the water begins to pass down the notice or overflow pipe into the regulating tank, D, and raises the float, A x, which is connected with the lever of cock A, and carries it up with it, whereby the cock is closed and the supply cut off. As the water enters the house cistern more quickly than it passes out by the overflow pipe, the overflow continues long enough after the supply has been cut off to raise the second float, B x, which is connected with the second or exhausting cock, B; and as the action of this cock is the reverse of the other the rising of the float opens it, and allows all the water lying in the rising main, O, to run out. The cock, B, opens immediately after the cock, A, has been closed, and therefore the pipes are always empty, except when the water is actually running in them, and they cannot be frozen up, obstructed, or burst by frost.

The regulating tank, D, consists of two parts, a lower cylindrical portion in which the floats lie, and occupied almost altogether by them, so that a very small quantity of water from the overflow pipe is sufficient to raise them, and their action is very rapid. The upper portion of the tank is expanded, so as to store up for future use the water that escapes from the pipes when the cock, B, is opened. A portion of the front of the tank has been cut away in fig. 1 to show the floats, &c., in their position. Fig. 2 is a side view, and G is an overflow pipe from the upper part of this tank.

To turn on the water into the house it is only necessary to empty the tank. For this purpose a pipe leads from the bottom of it, in which there is a valve, K, connected by a wire, I, with the lever, L, and opened

Fig. 1.

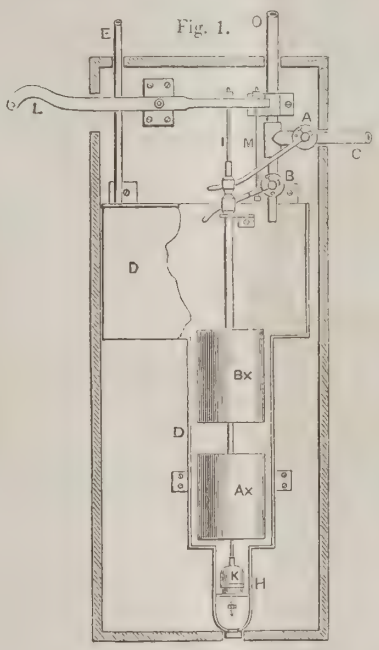
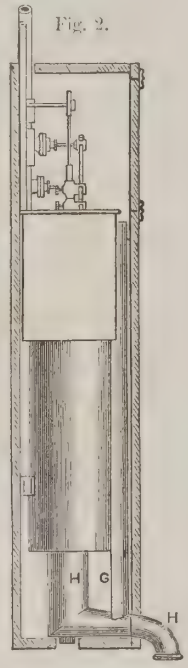


Fig. 2.



by depressing the handle of the lever; when this is done the float, B x, first falls, and in doing so shuts the cock, B, and then the float, A x, falls and opens the cock, A, when the water enters the house and continues to run till all the cisterns are full, and it is cut off again by the overflow. It is intended to place the apparatus in the kitchen or scullery, and let all the water used for kitchen purposes be drawn from it; so that every time the servants require water they empty the tank, and turn the water on into the house, and thus the house cisterns are kept full without any special care and attention.

Lever L has a second wire, M, attached to it, which connects it with the handle of cock B. When the handle of the lever, L, is depressed this wire, M, holds the handle of cock B fixed and the cock open. As soon as the tank, D, is empty the float, A x, falls, and the cock, A, opens, allowing water to enter at A and escape at B into the tank, giving a continuous stream through pipe, H, direct from the main; and when a sufficiency has been obtained, and the handle of lever L is allowed to rise, the cock, B, closes, and also the valve, K, and the water runs into the house cisterns until they are filled. This arrangement serves a double purpose; for it not only affords a continuous stream for kitchen use, but also insures that no water shall pass into the house so long as valve K is open, and thus prevents accidents.

It must be admitted that nothing could be more perfect than the protection afforded by this apparatus to the rising main; but in public buildings and large establishments where the water is required at various points, and the distribution pipes may be liable to be frozen in their course, the one apparatus may be made to protect the whole series. To accomplish this small cisterns should be placed wherever the supply may be required, and a branch from the rising main brought to each cistern and a ball-cock placed on it, leaving the pipe leading to the highest cistern open, and an overflow pipe must be brought from this

cistern to the regulating tank. When the water is turned on it first fills the lowest cistern till the ball-cock closes; then the next in order; and lastly, the uppermost, from which the overflow, passing to the regulating tank, shuts off all further supply, and opens the exhausting-cock, B, when the rising main and all its branches are emptied.

The saving of houses, walls, ceilings, furniture, and goods from the injurious consequences that so often arise from the bursting of water pipes in consequence of their being too weak to resist the pressure of water supplied from high levels, or of their being frozen, is a problem that has long occupied attention, and has now been solved by this arrangement: the means by which it has been accomplished are so simple and so obvious that the only wonder is it had not been done long before. We have all of us had good reason to remember the damages done to houses and furniture by the bursting of water pipes during last winter, and the annoyances and manifold inconveniences caused by the freezing up and obstruction of pipes leading to water-closets, baths, kitchen-ranges, &c., even where they were not actually burst. A writer in the *Times*, in January last, states that the annual cost of repairing the damages done by the bursting of water pipes is, in London alone, fully half a million of money; this is probably an exaggeration, but who can estimate the discomfort and interference with health and domestic arrangements caused by frozen pipes in addition to the actual injury to property?

The protection afforded by this apparatus is the more perfect inasmuch as it is completely self-acting; for there is no danger of the pipes being left full just at the time the frost is coming, an oversight not very unlikely to occur if the emptying of them be allowed to depend on the attention of a servant. In Dublin, we are informed the apparatus has been introduced by Messrs. Edmundson & Co., and is coming very much into use in connection with the high-pressure water supply from the Vartry. It is found so perfect a protection that where pipes already exist through the houses, no matter how light and weak, they are not changed, though the water is supplied under a pressure of 150 to 200 feet; for as the supply is cut off where it enters the house, and the pipes are left open at the mouth, they have no pressure to bear but that of a column of water their own height, and if strong enough for low pressure, are perfectly safe, no matter how high the pressure may be.

There is no doubt that this arrangement is capable of meeting the two objects for which it is designed, and it is evidently far in advance of the very rude contrivance now commonly adopted in London houses; namely, the putting a common spindle valve in the supply cistern at top of the house, with a wire pull attached, so that this valve can be dropped in time of frost, and the descending mains kept empty except during the times water may be required from them in the house; and the putting in a stop-cock in the basement story on the supply main, so as to cut off the water from the house after the cistern has been filled, the supply main within this stop-cock being emptied of its contents either by drawing off for use in the basement, or by a small waste-cock specially provided.

Here are three connected hydraulic problems to be solved by servants, who are required to be ready for the solution whenever the thermometer ranges for some indefinite time to some indefinite number of degrees below 32° Fahr. In view of these distracting scientific difficulties and strain upon the domestic attention and memory, Jeames or Cook are much more likely to end the complication with, "Please, mum, the pipes is busted agin," or "missus" to receive the solution by taking an unexpected shower bath in the drawing-room, than that all these pipes and pipers should play in harmony and when wanted.

But as the soul of wit is brevity, so that of all domestic hydraulics should be simplicity, to which must be added automatic action. The last is here well provided for, but there is perhaps a little more complication of parts than ultimately may prove necessary for as completely meeting the conditions. We should also like to see valves substituted for the cocks A and B; for no matter how well made or well proportioned, taper pin-cocks when under heavy pressure are after a little time always leaky, or if not, stick fast, so that the levers do not act on them. This evil, on one side at least, is here met by large and powerful floats, but on the other it remains.

One great cause of the bursting of lead pipes in houses has not been noticed above, and is outside the range of Mr. Kidd's, or any other similar apparatus. It is the constantly repeated sudden shutting of tolerably large cocks by servants when drawing off water in the basement story. The column of water in the pipe descending from the cistern in the roof thus suddenly arrested visits a shock or blow upon the interior of the pipe, greatest at the bottom, and quite analogous to that of the hydraulic ram. This, continually repeated, at last bursts the pipe somewhere.

Two palliations may be, and have been, applied, viz., a small air vessel close within each such cock, and making the aperture through the cock pin in such a form as to close less abruptly, as by a thin spiral slit diagonal to the axis of the pin; but what is wanted is a simple form of cock for domestic use, that *cannot* be closed suddenly.—Ed.

CORN-DRYING APPARATUS.

(*Illustrated by Plate* 15.)

In wet seasons when corn has to be harvested in a damp state, its market value is in consequence much lowered. Hitherto all attempts to remedy this evil have failed either on the score of costliness, or the impracticability of the various schemes that have been adopted. All barley growers too, well know after a wet cold season how difficult of treatment the corn is. In such cases the expensive process of sweating has been necessary before germination can take place.

The corn-drying apparatus illustrated by the Plate engraving, has recently been patented by Messrs. Davey, Paxman, & Davey, of the Standard Iron Works, Colchester, and is intended to supply a remedy for this evil. When this apparatus is attached to a steam-thrashing machine it occupies the place of the ordinary barley hummeler, horning the barley and delivering the grain, however damp and cold, in a drier, brighter, and much improved condition, and at the same time that it is thrashed; so that by performing the thrashing and the drying under one operation, it is done at little cost and without loss of time or additional labour.

The corn-drying apparatus may be used apart from a steam thrashing machine, and will be found to be well adapted to the purposes of millers, corn merchants, maltsters, &c.

The nature of the invention consists in the use of steam or hot air, or of steam and hot air combined, to be employed as presently shown, for the drying of all kinds of grain, seed, pulse, hops, malt, brewers' grains, &c. One or more chambers of cylindrical or other suitable shape are employed, which chambers are jacketed and made hot by steam, hot air, or by other suitable means; and through these the corn is conducted and maintained in constant motion by agitators. The same agitators perform the double operation of keeping the corn in constant motion, and of carrying it through the machine. At the same time a current or blast of air of the required temperature is sent or drawn through the chambers in which the corn is being agitated, and so acting separately upon each grain, seed, or particle, dispels the moisture therefrom.

When the blast of air is required to be hot, it is derived from a stove or furnace, or is made to derive its heat from steam, gas, or other means, and is passed through the chambers by fans, pumps, bellows, or other apparatus.

The temperature to which the grain is exposed is indicated by a thermometer, and is under perfect control, being regulated by valves for admitting hot and cold air.

Fig. 1 of Plate 15 represents a side elevation of the improved apparatus for drying grain; fig. 2 is an end view of the same; and fig. 3 is a transverse section of the drying chambers. A is a cylinder vessel or chamber carried by the end standards, B; in this chamber three other smaller chambers, C, C′, C″ (fig. 3), are fitted, through which last-named chambers the grain to be dried is caused to pass by the action of the agitators, D, which extend throughout the entire length of the chambers. E is a feeding hopper for receiving the grain to be dried direct from the thrashing machine, or otherwise. This hopper is in communication with the upper cylinder, C, and is provided with a feeding roller, F, and an adjustable slide, G, for regulating the admission of the grain to the drying chambers. H is a stove for supplying hot air to the interior of the chambers; a fan-blower, I, being employed for forcing such air into and amongst the grain under treatment. The admission of the hot air is regulated by a damper or valve, K; and in order to regulate the temperature of the air, a valve, L, is provided for the admission of cold air when required: a thermometer, M, is placed in the passage, through which the air passes to the chamber,

CORN DRYING APPARATUS.

MESSRS J. N. PAXMAN & H. M. DAVEY.
STANDARD IRON WORKS.
COLCHESTER.
PATENTEES.

Fig. 1.

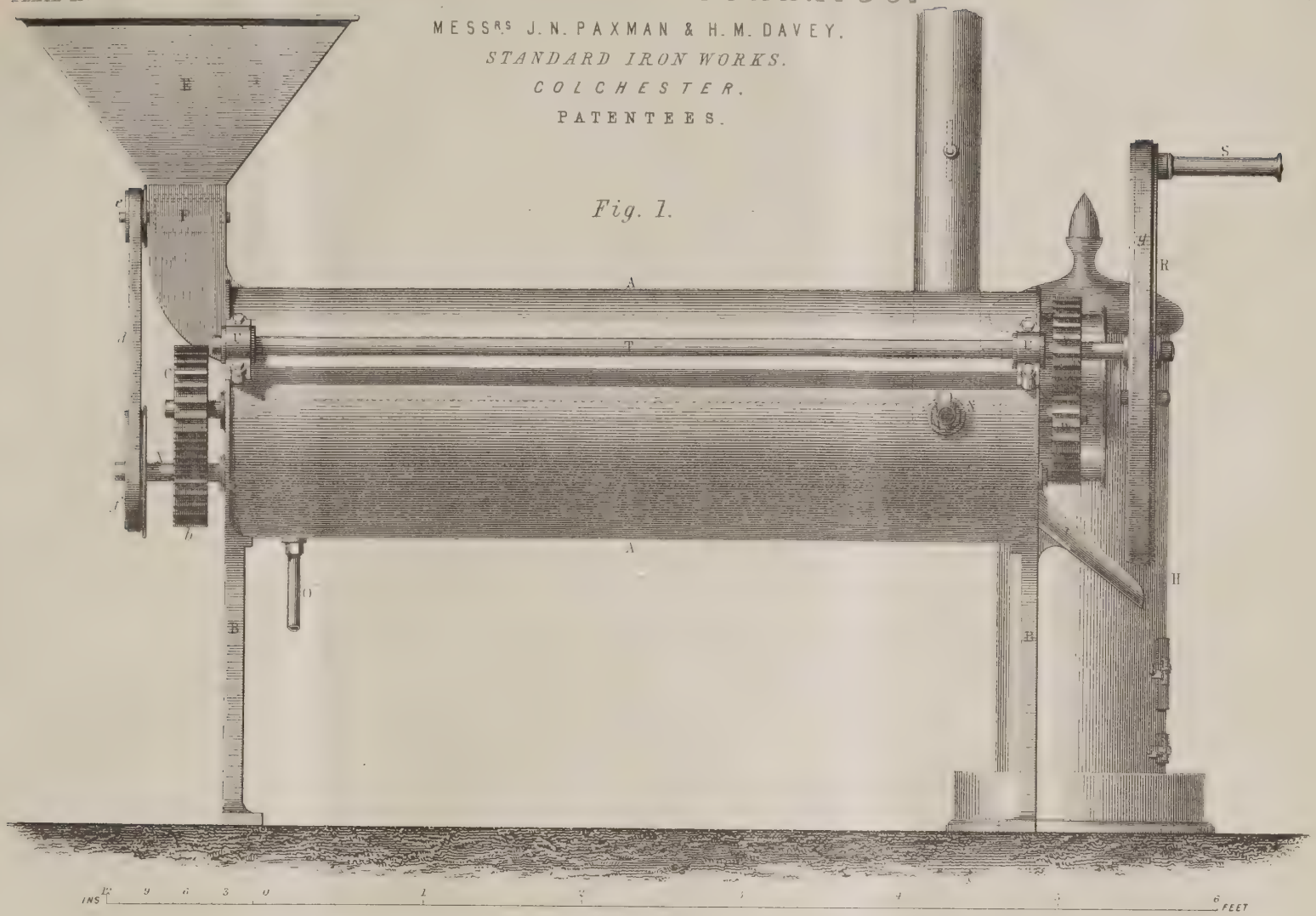
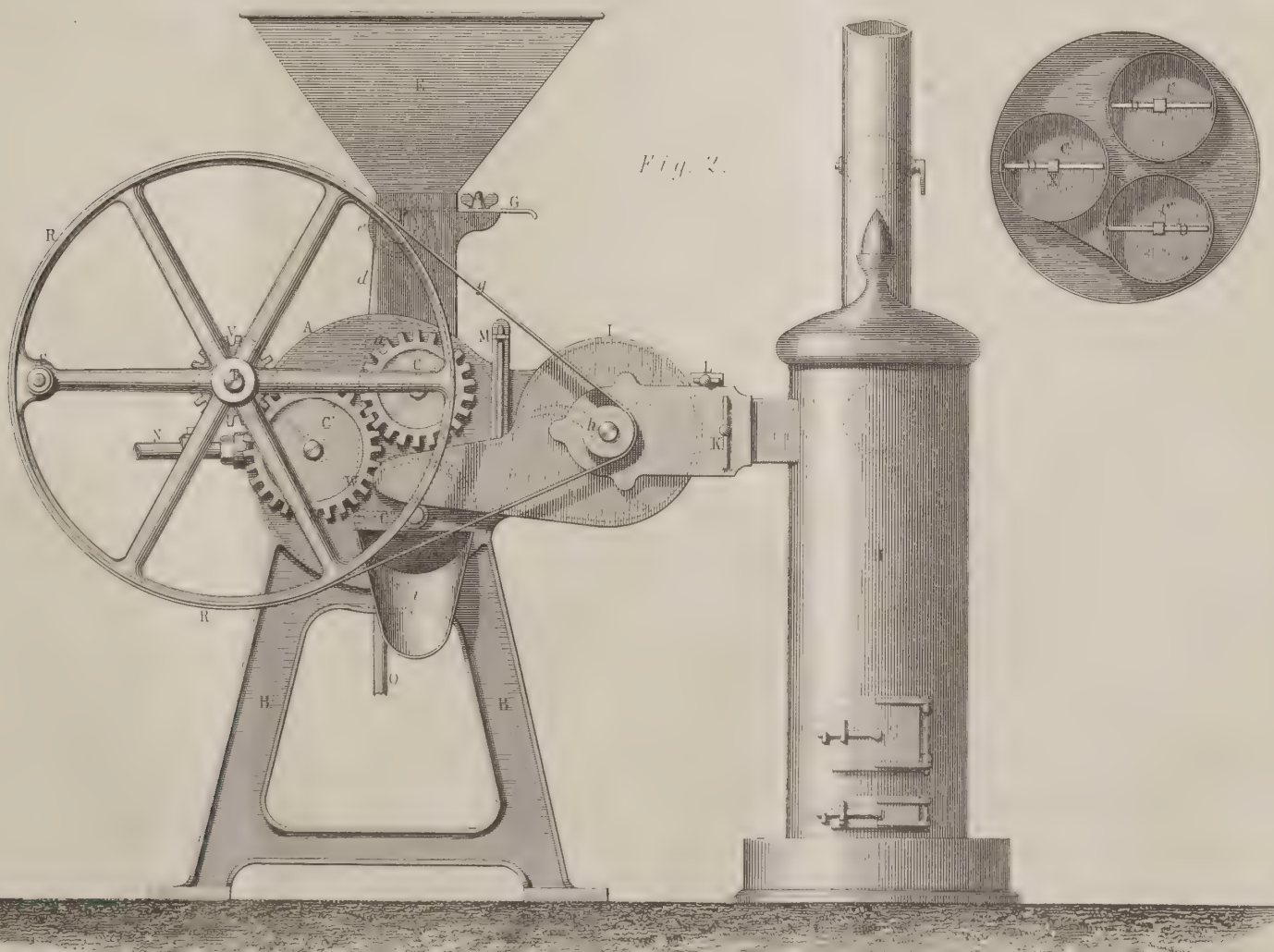


Fig. 2.



Fig

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by means of which the degree of temperature may be readily ascertained. In some cases it may be advantageous to use steam as the drying medium, in which case the steam is admitted into the outer cylinder, A, through the steam pipe, N, leading from the boiler of the engine of a steam-thrashing machine with which the improved drying apparatus may be combined, or from any other convenient source. The steam, after having circulated round and about the exterior of the internal chambers, escapes through the pipe, O. These steam pipes may be provided with stop-cocks or valves, for regulating the admission and escape of the steam. If desired, both steam and hot air may be employed at the same time; the one acting on the exterior of the chambers, and the other in the interior and amongst the grain. R is the driving wheel, which may be worked by the handle, S, or by steam or other power, in any suitable way. This wheel is fitted on to one end of the shaft, T, carried in bearings, U, attached to the outer cylinder, A. This shaft carries a pinion, V, which is made to gear with a toothed wheel, W, fitted on to one end of the shaft or spindle, X, carrying the agitators, which work in the chamber, C′. Motion is imparted to the agitators in the chamber, C, by the toothed wheel, *a*, gearing with the wheel, W. On the opposite end of the spindle, X, there is fitted another toothed wheel, *b*, which imparts motion to the agitators in the chamber, C″, by gearing with the wheel, *c*. The feeding roller, F, is actuated by means of the band, *d*, which passes round the pulley, *e*, carried by the spindle of the roller and the pulley, *f*, carried on the spindle, X: *g* is a driving band for imparting motion to the fan-blower, I, by passing round the driving wheel, R, and the pulley, *h*, carried by the fan spindle.

The grain to be dried, which may be delivered direct from the thrashing machine or otherwise into the hopper, E, is fed by the roller, F, into the upper drying chamber, C; it is there acted on and propelled to the further end thereof by the agitators, D, and then descends through a suitable aperture into the next lower chamber, C′, where it is again agitated and propelled the entire length of this chamber, and made to descend into the third and lowest chamber, C″, where it is again similarly acted on and finally issues through the delivery spout, *i*, in a perfectly dry state; hot air having been forced into and amongst the grain during its passage through the chambers. When this apparatus is attached to a steam-thrashing machine, and made to take the place of the ordinary barley hummeler, the agitator in the chamber, C, is made to perform the operation of horning the barley, and the standards, B, the feed roller, F, and the hopper, E, are dispensed with.

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RECENT PATENTS.

STEAM BOILER AND OTHER FURNACES.

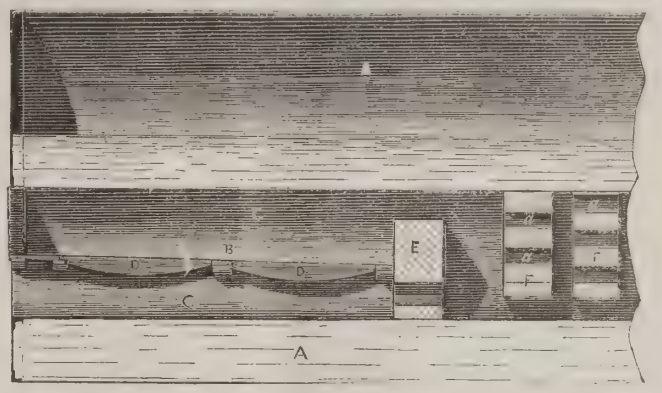
H. Chamberlain, *Wakefield.—Patent dated 20th May*, 1867.

This invention relates to an improved mode of applying and economizing the heat of steam-boiler and other furnaces, and consists in storing a large proportion of the heat which has hitherto been lost or wasted, by being carried by the draught up the chimney before it has had sufficient time to become absorbed by the boiler plates or other surface to be heated. According to this invention, as applied to marine and Cornish boilers, for example, it is proposed to pack or fill in the flue behind the furnace or fire-bridge with open brickwork of fire-brick, fire-tiles, or fire-clay lumps, made either solid or hollow, the interstices being so disposed as to sift the current of hot air without stopping the draught. By this means the heat which is not immediately taken up by the boiler plates is stored in, or collected by, the fire-bricks, whence it radiates off to the boiler. These fire-bricks soon attain a very elevated temperature throughout the entire portion or length of the flue in which they are placed, and impart a more uniform degree of heat throughout the length of such flue.

An additional supply of air may with this arrangement be admitted to the fuel above the grate, and hence a more perfect combination is obtained, and the prevention of smoke effected with a corresponding economy of fuel.

Fig. 1 of the engravings represents a longitudinal vertical section of a Cornish boiler, the internal flue of which is packed with open brickwork, which acts as a magazine or storer of heat without sensibly impeding the draught. A is the shell of the boiler; B, the furnace, constructed in the ordinary manner in the internal flue, C; D D are the

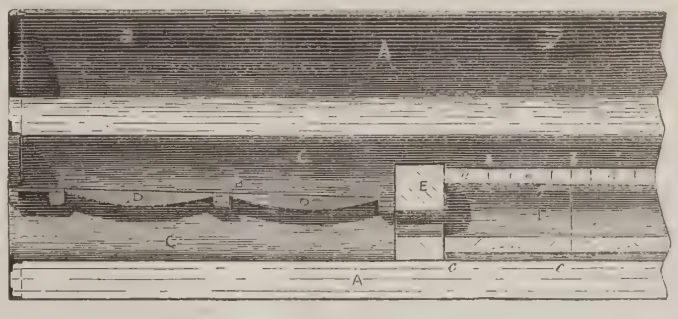
Fig. 1.



fire-bars, and E, the fire-bridge. Behind the furnace and fire-bridge is packed into the flue a range or series of fire-bricks, F F, extending along the whole or the greater portion of the length of the flue; open spaces, *a a*, being left between the fire-bricks, in order that the current of hot air may be sifted, as it were, without, at the same time, sensibly obstructing the draught.

Fig. 2 represents a longitudinal vertical section of a modification of the arrangement shown at fig. 1. A is the boiler shell; B, the furnace; C, the internal flue; D D, the fire-bars; E, the bridge, and F F, the fire-

Fig. 2.



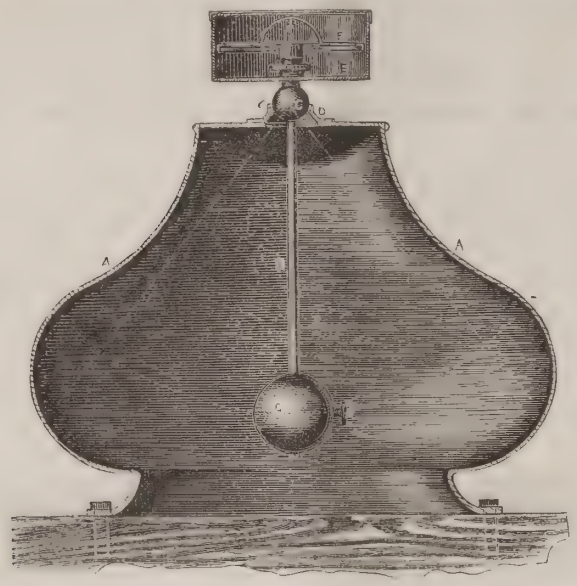
clay heat magazine, which in this case is applied in the form of tubes, laid along the full length, or the greater portion of the length, of the flue, C, and supported in their places in the bottom of the flue by bricks, *c c*, at every joint. These fire-clay tubes are in free communication with the ashpit through the opening shown, and are closed at their inner end. They are perforated on their upper surfaces, as shown at *a*; the several joints at *b b* being also left sufficiently open to allow of the escape of hot air from the interior of the tubes through the joints, *b*, as well as through the perforations, *a*, into the flue, C, where the several jets of hot air mix with the unconsumed gases or products of combustion, and effect their ignition, thereby preventing the formation of smoke. The heat from the furnace soon raises the fire-clay tubes to a red heat, and consequently the air which enters therein from the ashpit is considerably elevated in temperature before it issues, in the form of a number of fine jets, through the lateral perforations or openings in the tubes, and mingles with the gases which are thereby ignited. A more perfect combustion and prevention of smoke is thus obtained, as well as a more uniform temperature throughout the flue, produced by the radiation from the highly heated tubes in such flue.

SHIPS' COMPASSES.

The Right Honourable James, Earl of Caithness.—*Patent dated 31st May*, 1867.

This invention relates to a mode of suspending ships' compasses, with a view to prevent undue oscillation in heavy seas, and consists essentially in attaching to the compass box, or case containing the card or needle,

a weighted rod or pendulum, which is allowed to swing freely by a ball and socket joint situate as close as possible to the compass. The socket for the ball is contained in the upper part of a "binnacle" or other convenient frame or support which will allow of the free play or swing of the pendulum. The bob or weight of the pendulum is made adjustable along the rod by a set screw or other convenient contrivance, so as to admit of alteration or adjustment. By this contrivance the compass is constantly maintained in a horizontal position, as whatever may be the motion of the ship the pendulum will always remain perpendicular. The accompanying engraving represents a vertical section of a mariner's compass mounted according to this invention. A is the "binnacle" or case, the sides of which should incline outwards towards the lower portion, or be otherwise constituted or shaped, so as to afford free swing inside the "binnacle" for the weighted pendulum,



B, in roughest weather. On the upper end of the rod of the pendulum there is fitted or formed a ball, C, which turns freely in any direction in a socket or holder of brass or other suitable material, D, carried by and secured to the top of the "binnacle" or support in any convenient or suitable manner. In the upper side of the ball, C, is secured by the aid of a screw, *a*, the compass box, E, containing the ordinary pivoted card or needle, F, protected by a glass in the usual manner. The whole should be inclosed or protected by an outer casing of any convenient form, provided with a glass with suitable "binnacle lamps." The pendulum may be made of any length, but it has been found that a length of about 2 feet 6 inches from the centre of oscillation to the centre of the weight or pendulum bob, G, answers well in practice, and it is preferred to make such weight adjustable along the pendulum rod to secure it at any desired height by means of a pinching screw, *b*, or by any other convenient contrivance. In order to prevent the accidental rotation or circular displacement of the compass box, it is proposed to insert a pin, C, through the side of the socket or holder, D, into a groove or channel made in the side of the ball, C.

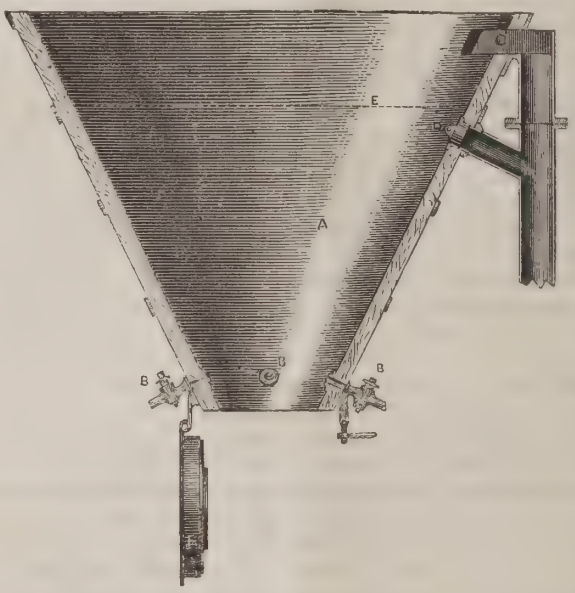
TREATING ANIMAL CHARCOAL.

J. Stenhouse, *Pentonville*, and J. Duncan, *West Ham.—Patent dated 21st May*, 1867.

It is well known that when animal charcoal has been employed to decolorize syrups or saccharine solutions, it gradually absorbs lime and other earthy or alkaline substances, by which its decolorizing and absorbent powers are diminished; and the object of the present invention is to effect a more thorough cleansing of this charcoal preparatory to its being re-used. In carrying out the invention a quantity of this used charcoal is washed well with boiling water, and then introduced into a suitable tank, or cistern, containing hot water slightly acidulated with nitric acid. The quantity of nitric acid used should not be more than sufficient to neutralize the lime and other earthy or alkaline substances present in the charcoal, as if an excess of the acid were employed, it would dissolve out a portion of the phosphate of lime and thus injure the texture of the charcoal. It is necessary to ascertain, by a preliminary experiment on a small scale, the quantity of acid required in each case to neutralize the lime and other basic substances present in the charcoal, since their amount varies considerably.

When the charcoal and acid solution have been digested for half an hour to one hour, which is best effected by blowing steam into the mixture, the saline solution consisting chiefly of nitrate of lime is removed, and the charcoal repeatedly washed with either hot or cold water, as is most convenient, until all soluble impurities are removed. When dry it is ready to be reburned, and is again fit for use. The process just described can also be advantageously applied to new animal charcoal before it has been used in sugar refining, as it removes impurities naturally present in the charcoal, which diminish its decolorizing and absorbent properties.

The tank employed in washing the charcoal is most advantageously made of a circular form, with the sides sloping inwards towards the bottom. At convenient heights in the sides are pipes, through which the water can be admitted or drawn off. These can be closed by plugs or stop-cocks, made of wood or earthenware, or any other suitable material not acted upon by the dilute acid. The water employed for washing out the charcoal is introduced under pressure near the bottom, through openings for that purpose; so that it thoroughly permeates the charcoal and washes out the impurities present, the water flowing out through other pipes situated nearer the top. After the charcoal has been sufficiently washed, it is withdrawn from the tank through a flap door at the bottom. The tank is made of wood, slate, earthenware, or any other material not acted upon by the dilute



nitric acid. The engraving represents a sectional elevation of the tank and fittings, which it is proposed to employ in washing animal charcoal. A is the tank or vessel for holding the charcoal to be treated. In the sides of this tank, and situated near the bottom thereof, are fitted a series of cocks, B, for the admission of steam or water under pressure. Near the upper edge of the tank there is provided an overflow pipe, C, for the escape of the washings, and beneath this there is a pipe and plug, D, for draining off any excess of water from the surface of the charcoal, the level of which whilst under treatment is represented by the dotted line, E. A flap door, F, is hinged to the bottom of the tank, for the purpose of discharging the charcoal after it has been cleansed.

DISTRIBUTING AND MEASURING FLUIDS.

R. H. Frith, *Dublin.—Patent dated 20th April*, 1867.

This invention relates more particularly to the distribution and measuring of fluids used for domestic purposes, such, for example, as water, and is applicable also to the distribution and measuring of gas or steam. According to this invention, as applied to the water supply of a house or manufactory, it is proposed to combine the two pipes, hitherto known

as the supply and distributing pipes, in one; the same pipe which admits water from the street main into the house cistern serving also to distribute the water from the cistern to the house, or to out-buildings, as may be required. For this purpose a two-way cock is fitted to the supply pipe, the barrel of such cock having three or more lateral branches or ducts formed thereon, according to the number of places to which the water in the cistern is to be distributed. In the simplest form of cock the barrel will be provided with three lateral openings; the first communicating with the supply pipe leading to the main, the second with a pipe leading direct to the bottom of the cistern, and the third with a distributing pipe leading to the kitchen, scullery, or other convenient part of the establishment. By suitably turning or adjusting the plug of the two-way cock, the water may be admitted direct from the main into the cistern, so as to fill the same, the distributing pipe being at that time shut off; or the supply pipe may be shut off, and the water drawn from the cistern through the distributing pipe for the house service. In all cases the water from the main must first enter the cistern before it can be drawn off at the house tap. Should it be required to supply, in addition to the house, stables or workshops, then an extra pipe must be connected with the barrel of the regulating cock, and the two-way thoroughfare through the plug of the cock should be expanded or bell-mouthed, so as to enable a communication to be established between either one of the two distributing pipes and the pipe leading direct to the cistern. The upper end of the cistern pipe is connected with a valve chamber, containing a valve opening downwards, so that when such valve is held up it closes the aperture in the bottom of the cistern, and prevents an excess of water being admitted from the supply pipe. The lower portion of the stem of this valve, which projects inside the cistern, is made hollow, and is perforated round its circumference, so as to afford a free access of water into the hollow portion of the valve, which, for the sake of distinction, is called the "stop valve." Underneath the bottom of this hollow spindle there is fitted a small valve or traveller, also opening downwards, and fitting when raised close against the central aperture in the stop valve. The stop valve has a long spindle or rod connected to it, and extending from the bottom to the top of the cistern, where it is guided or maintained in a vertical position by a fixed support or collar, through which it is free to rise and fall. On this spindle there is fitted a float, which rises and falls with the level of the water in the cistern within a certain range, sufficient to effect the full opening or closing of the stop valve in connection therewith. When the cistern is full, the buoyancy of the float will maintain the stop valve closed; that is to say, it will hold that valve tight against the underside of the supply aperture in the bottom of the cistern, so that no further supply from the main can be admitted therein, even when the regulating cock is turned for that purpose. When water is drawn off through either of the distributing pipes, it first flows down through the hollow valve spindle, the small valve or traveller readily falling and opening for that purpose so soon as the pressure from the main is cut off, and by the time a perceptible lowering of the level of the water in the cistern takes place, the corresponding descent of the float, and consequent opening of the stop valve, enables a further supply to be admitted if desired, till all the water in the cistern be drawn off, and the rising of the float closes the stop valve again. The water may, however, be drawn off till the cistern is empty, and may then be filled at one operation, till the closing of the stop valve prevents further ingress of the water. The stop valve is protected from the direct pressure of the main by an annular shield, formed round the interior of the valve chamber, a series of water ways being formed in the annular space between the shield and the exterior of the chamber. In order to measure the quantity of water drawn from the supply cistern, a movable float is adjusted on the vertical spindle before referred to, which float is free to move up or down nearly the entire length of spindle, according to the varying position of the water level. To this float there is attached one end of a pin-jointed chain, each link of which is curved to correspond to an arc of the circumference of an overhead pulley, over which the chain passes. Teeth, or cogs, are also formed on one edge of each link, so that the chain presents the appearance of a flexible rack. A counterweight is hung to the free end of this chain, for the purpose of balancing the weight of the float. The teeth on the chain engage with the teeth of a horizontal spur-wheel, which, by means of a pall and ratchet arrangement, is free to revolve loosely round its shaft when the float is rising, so as not to impart motion to such shaft; but when the float descends, by reason of the drawing off of the water, then the pall and ratchet being engaged together cause the shaft of the spur-wheel to revolve. On the top of this shaft there is fitted a pinion, which gears into the first of a train of wheels forming a counter, and thereby the amount of water drawn off is accurately registered, each inch or part of an inch in the fall of the level of the water being shown on the dial or dials of the counter; and if the superficial area of the cistern be given, the amount of water drawn off for each inch or fraction of an inch can be readily calculated.

SECURING WINDOWS.

ROBERT LOGAN, *Glasgow.—Patent dated 10th June*, 1867.

THIS invention relates to an arrangement or combination of mechanism which is applied for the purpose of regulating the amount of opening of, and adjusting or fixing at a desired extent of opening, sliding windows, blinds, and shades, as well as doors and shutters; and it consists in employing one or more racks having ratchet teeth on them, which racks are attached to some convenient part of the framing. The movable part of the window, blind, shade, shutter, or door has one or more ratchet palls fixed to it, and which is or are acted upon by a spring, and by it forced into the recesses of the teeth. The pall is connected by a link to one end of a bell-crank, the other end of the bell-crank being attached to a lever which is fastened into the framing; this lever being so formed that it serves for withdrawing the pall or palls from the ratchet teeth, so that the part to which it is fixed may be lowered. It also, in combination with a fixed projection, serves the purpose of a thumb and finger piece by which the window, blind, shade, door, or shutter may be held for the purpose of raising or lowering. On releasing the pressure of the thumb and finger from the lever, the pall or palls fall into one or more ratchet teeth, and the window, blind, shade, door, or shutter becomes at once fixed in any position of opening desired.

The mode of working the arrangement is as follows:—When it is desired to lower the window the thumb-plate is pressed down to the finger-plate; the pin or lever turns the bell crank, and the bolt or pall is withdrawn from the rack. The window is then lowered the desired distance, and the thumb-plate is relieved; the bolt is immediately pushed out into the teeth of the rack by the spiral spring, and the window is secure.

It may be mentioned that this invention is peculiarly applicable to railway carriage windows, and we hope soon to see the railway companies adopt the system. There can be but one opinion as to the necessity for some such improvements for the working of the sliding windows in railway carriages. The contrivances at present in use for such purposes are anything but convenient or efficient for passengers to operate; in the third class carriages on most of our railways (north of the Tweed at least) passengers are either chilled with the draft when the window is open, or nearly suffocated with confined air when the windows are closed, as there is no means of keeping the windows in a midway position. By the adoption of the above simple contrivance, which would be very inexpensive, such windows could be fixed at any desired position, and the action is so simple that it could be operated by any person with the greatest ease.

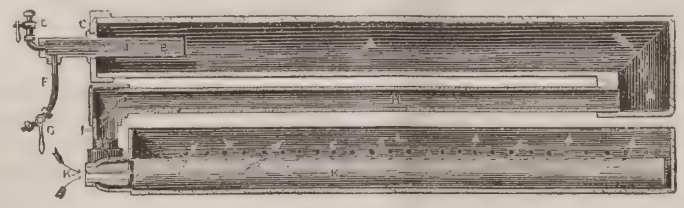
UTILIZING THE HEATING PROPERTIES OF PETROLEUM AND OTHER LIQUID HYDROCARBONS AND OILS.

ARTHUR BARFF and JOSHUA KIDD, *London.—Patent dated 29th March*, 1867.

THIS invention relates to a mode of, and apparatus for, utilizing the heating properties of petroleum and other liquid hydrocarbons, as well as vegetable and animal oils. In carrying out the invention, with a view to the generation of steam, a closed, or in some cases, a perforated retort or chamber is employed, which is situate in what would be the ordinary furnace or fire-box of the steam generator, and this retort is maintained at or near a low red heat. Into the interior of the heated retort is injected, by the aid of saturated or superheated steam, petroleum, or other mineral oil, or liquid hydrocarbon, or any vegetable or animal oil; taking care that the oil so injected shall enter the retort in the form of spray or mist, mingled with the steam which has been employed in injecting it. The small particles of oil are thus held mechanically

suspended by the steam in the retort, until they are vaporized by the heat of the retort being only just sufficient to vaporize the oil without decomposing it, which would have the effect of producing a permanent gas; or the oil may be simply dropped into the retort, with a view to vaporizing it. This vapour is then carried by the steam through a pipe or pipes to a burner or burners situate beneath the retort, where it is ignited and burned as fuel; the heat obtained serving not only to maintain the retort at the required temperature, but also to generate

Fig. 1.



steam in the boiler; or the mixed vapours may escape into the fire-box or furnace through suitable perforations made, either in the retort itself, or through an outer case or jacket surrounding or communicating with the interior of the retort. One form of apparatus, which is found to answer well in practice, consists of a cylindrical retort, from which leads a branch pipe communicating with another pipe carrying the burners, which may be situate in any convenient position. An air pipe, provided with a regulating valve, is made to supply the exact amount of air, which is induced by and mingled with the jets of vapour which produce the flame required. Through the centre of a hollow cap or

Fig. 3.

socket secured to the end of the retort passes a pipe, which is connected by a stop-cock and branch with the oil reservoir outside of and surrounding this oil pipe, but inside the retort there is fitted another pipe of larger bore, so as to leave a free annular passage for steam between the exterior of the oil pipe and the interior of the steam pipe. This steam pipe communicates through a branch and stop-cock with the steam generator. If preferred this arrangement may be reversed, the steam being admitted through the inner or central pipe and the oil through the outer pipe. On turning on the steam a current of oil is induced, which is forcibly directed into the retort by the jet of steam, and is instantly broken up into spray or mist inside the retort. If desired, a finely perforated rose may be fitted on to the end of the steam pipe. The spray thus produced before it can make its exit from the retort becomes vaporized, and is burned in the form of a condensible inflammable vapour mixed with steam and a small proportion of air at the burners; such air being admitted either through the ordinary furnace door or grate, or mixed with the vapour by the induced current produced by its escape through the burners. In order to disperse the flame as much as possible in the fire-box or furnace, it is preferred to construct across the same a species of fire-bridge, or baffle, or wall of fire-brick, in front of the burner or burners; and in some cases, with a view to spreading the flame evenly throughout the furnace, a pipe having one or more slits made longitudinally therein is employed as a burner, through which slits the vapour issues, and is burned in the form of a vast sheet of flame. According to another arrangement an injector is employed, wherein the steam jet passes over or across the orifice of the oil pipe, thereby inducing the oil along the pipe, and blowing it into spray as fast as it issues; or separate oil and steam pipes may be employed, each perforated and placed parallel and near to each other, the oil pipe being a little above the steam pipe. As the oil issues in the form of drops from the perforations, these drops are instantly disintegrated or blown into spray by the jets of steam issuing from the corresponding or opposite perforations in the steam pipe.

Fig. 1 of the annexed engravings represents a longitudinal section of a retort and burner, constructed and arranged according to this invention; and fig. 2 is a transverse section of the same looking towards the front end of the retort. A is the retort, one or more of which is or are to be placed in the furnace or fire-box of a steam boiler when employed for the generation of steam. This retort may be of cast or wrought iron, or clay, of any convenient form and dimensions; but it is preferred to make it D-shaped or flat, so as to get as much heating surface as possible. Into the front end of the retort there is fitted an injector for blowing, by the aid of steam, liquid hydrocarbon or other oil in the form of spray into and along the interior of the retort. This injector may consist of a nozzle, B, screwed or otherwise secured to the front end or removable cap, C, of the retort. Within this nozzle, B, there is situate a smaller nozzle or steam jet pipe, D, which communicates by the pipe and stop-cock, E, with the steam generator. F is a pipe communicating with the nozzle, B, and leading to an oil or liquid hydrocarbon reservoir, a cock, G, being also provided for shutting off or regulating the supply of oil. The inner or further end of the retort, A, is made to dip, as shown at A′, where it communicates with the tube, H, the front end of which is connected by an elbow bend with the short vertical tube, I, leading direct into the long perforated or slotted burner, K.

Fig. 2.

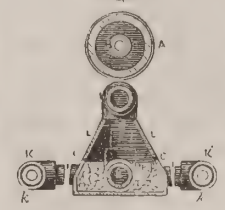
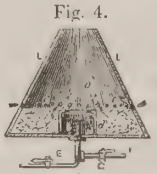


Fig. 3 is a longitudinal section of a slightly modified arrangement, wherein, in lieu of using a separate retort and burners, as in figs. 1 and 2, the retort and burner is combined in one apparatus. A is the retort, which in this modification is perforated, as shown at *a a*, in order that the inflammable vapour may issue therefrom, and be burned direct in the furnace or fire-box; the retort not only serving for the vaporization of the liquid hydrocarbon injected or otherwise introduced therein, but also in the burner for the same. The injector consists, as before described, of a nozzle, B, within which is situate a steam jet pipe, D. B′ is a pipe surrounding the nozzle, B, its object being to allow a regulated quantity of air to be induced into the retort through the regulating orifice at D. This form of injector may be also applied to the retort shown in figs. 1 and 2. The retort is inclosed in a jacket or case, L, provided with coke or porous material, as before described, which coke is maintained more or less constantly saturated with that portion of the oil which is not completely vaporized, and which escapes from the bottom of the retort, A, into and amongst the coke, through holes, *d d*, made in the retort for that purpose; or the oil may be dropped or separately supplied by a pipe to the porous material in the outer case or jacket, L. The case or jacket, L, is provided with air holes, *c c*, and serves to direct the air to that part of the flame where its admixture will produce the most perfect combustion.

Fig. 4.



REVIEWS OF NEW BOOKS.

A Treatise on the Strength of Materials, By Peter Barlow, F.R.S. A new Edition, revised by his Sons, P. W. Barlow and W. H. Barlow, and Edited by Wm. Humber, C.E. 1 vol. 8vo, with Plates. Lochwood & Co. London. 1867.

Books, like men, grow old, and at a certain age defy the doctor's power, or any other means by which the strength and vitality of their youth can be again imparted to them. When this point has been passed, men and books are best permitted alike to die in retirement and peace. With every desire to speak well of this latest edition of this now very old work, we are unable to avoid in honesty saying, that we think the sons of the late Professor Barlow would have done well to have adopted the course we have mentioned. We admire and respect the filial feeling that no doubt has in some degree prompted them; but their father's scientific memory needed not any reviving, and least of all such as we have here. The fame of the late Professor Barlow rests upon a far broader and firmer basis than his work on the strength of timber, produced as long ago as 1817. His papers in the *Philosophical Transactions* and elsewhere; his careful and early researches in magnetism; and, above all, some of his luminous and masterly reports upon public subjects involving questions of mixed mathematics, mechanics, and physics (such, for example, as that upon the atmospheric railway as a system of propulsion)—are the genuine and enduring temple in which his sterling and almost self-taught genius are enshrined by fame, and in the recognition of those of his countrymen, and of the world of science, best competent to have appreciated him. It might have been a suitable

task worthily to prolong his memory with the present generation, had his sons published, without garbling or addition, a collected edition of his researches, memoirs, and reports, &c., and we should still welcome such a work. The work now under our hand is, however, a mistake, one equally, we think, as respects the aims and wishes of its revising authors, as towards the engineering public. The work on the strength and stress of timber was originally published in 1817, and was, as its title stated, almost confined to timber. Three editions were in succession sold off before 1837, and to each of these additions were made of data and experiments in relation to other materials, until it assumed a new title, and became a "Treatise on the Strength of Timber, Cast Iron, Malleable Iron, and other Materials." In 1837 the fourth edition appeared, and in addition to all the more or less directly germain matter which had been piled into the former ones one after the other, there was now added a bulky appendix, much of which had nothing whatever to do with the proper subject matter of the work, such as the chapter on the power of locomotive engines, and that on the effect of gradients, &c. A fifth edition appeared in 1851, neither much enlarged nor improved, and so the work stood still for sixteen years until now. The world, however, has not stood still. In 1817 English technical literature was deplorably deficient; exact works on physics and applied mathematics or mechanics, we might say scarcely existed anywhere in a form capable of being of use to the practician. There was a considerable mass of doctrine (more or less correct), and of experimental data, wrapped up in French, Italian, Spanish, and German languages, to the average Englishmen of that day as unreadable as Sanscrit. Dr. Robison, of Edinburgh, Dr. O. Gregory, and one or two more early stars of British technical knowledge, had produced some most luminous and important works, or articles, the keen intellectual radiance of which continue undimmed still, and form no small part of the light of posterior writers; but these were for a few only, and dealt rather with principles than practice or in data for the latter. By condensing into one view and placing in an exact form the fundamental theory of stress upon imperfectly rigid bodies, as delivered by these or by foreign authors, and by collecting into one view the data scattered through some of the latter, and adding his own deduced from experiment, Professor Barlow, in 1817, conferred an inestimable benefit upon British practice of that day in engineering and mechanics. But the work was one produced in the infancy of applied science, when, as its author himself says, "the construction of suspension bridges was in its infancy, and the application of malleable iron for the purposes of railways unknown." Remodelled as it was, however, in 1837, or rather, to be more correct, enlarged as it was with new subjects, the work had, as a standard work upon the strength of materials, already begun to fall behind the march of knowledge, and during the ten years that elapsed between 1841 and 1851, when the fifth edition appeared, it is only truth to say, that the work continued to be employed in Great Britain, or to maintain its position, mainly because what had been discovered and done abroad was unknown to many amongst us, and because British engineers and mechanicians generally had no other book of the sort to refer to.

But if this were in any wise true in 1851, how intensely had it become so now, when during the sixteen years that had elapsed again, the whole mathematical science (so to say) of stress and strain, had been created upon the Continent, clear notions of the relations of these to the molecular constitution of bodies established, and the doctrine of "work" applied to stresses actively applied. Besides which, in this interval some of the most important and extensive trains of experiment, for the determination of data as to the properties of materials in resisting variously applied stresses, that the world has ever been endowed with, had been made.

To any one contemplating the volume of 1851, in the full light and knowledge, then, of what has been achieved since in the science and data of stress and strain, we say it ought to have been at once obvious that to put new wine into old bottles, or adopt a scheme of patchwork upon an old garment, must have but its old and proverbial results. The work should have been let alone; for to bring it into symmetric harmony with the existing state of knowledge was impossible; with few exceptions it must have been re-written as to all its theoretic and investigative portions, not, perhaps, because these were false, but because they did not, and do not, contain anything like the amount and sort of truth that has since been discovered, and now forms the instrument of practice.

We have very little doubt but that this may sound strange or doubtful to many of our readers, but if so it is simply because the existing state of continental science as respects stress and strain is scarcely at all even yet known to practitioners in this country. One may count on his fingers all the British authors who have mathematically investigated the subject in a fundamental and absolute manner. Stokes, Thompson, Maxwell, Rankine, Moseley, go far to exhaust the list; and amongst these there is but one in any wise a practical engineer. These, and a few others engaged either with abstract science or in practice, no doubt are well acquainted with the existing state of the science which they assist in leading both at home and abroad. But the vast body of British engineers and mechanicians know, in effect, next to nothing of the advances, the revolution we may say, that the science of the resistance of materials has undergone in having had its foundations laid upon molecular physics, and in its method of view and treatment, at the hands of such men of late years as Navier, Lamé, Brix, Barre de Saint Venant, Poncelet, and others, or how large and important are the contributions that have been made to experimental data by another class of continental authors.

A single hint of the results of all this progress abroad, or apparently any idea of its existence, we do not find in this new edition of Professor Barlow's work. What we, however, do find, is that it is made still more ponderous and not one whit more valuable, if even as good as before, by compiling into it whole masses of material already accessible in print at the fountain heads elsewhere.

Thus, under the not quite candid title of *an Essay* "On the Effects produced by causing Weights to travel over Elastic Bars," we have the appendix to Professor Willis' "Appendix to the Report of the Commissioners on Railway Structures" (A.D. 1849), transferred bodily from the Blue-book into the volume; and the same thing done as respects Mr. Fairbairn's experiments on vibratory strains on girders, as to Mr. Kirkaldy's tension experiments, and as to Eaton Hodgkinson's earliest experiments upon the best form of cast-iron beams, all of which, Goodness knows, have been repeated and reprinted, and re-reproduced over and over again, until the very name of them begins to be tiresome.

It is not this sort of higgledy-piggledy compilation that is useful, or can tend to prolong in honour Professor Barlow's name. If it were resolved to publish a new edition at all hazard, then should it have had its text left just as its author left it. Its editor, if up to his task (and we by no means intend to suggest that Mr. Humber, whose information and general accuracy, as well as practical and theoretic knowledge, are well known, is not so), should in our judgment have simply supplied in briefly and well written footnotes, such information as would have filled up, or at least have informed the reader of, the *lacunæ* that nearly half a century have necessarily left in the bequest of knowledge descended to us from his author. But this, unhappily, is just what has not been done, even, so far as we can see, in a single instance; so that in what sense the work can be said to have been *revised* we are rather at a loss to see.

We might adduce numerous examples. One or two will suffice to show that we are not disposed to criticise harshly or without grounds.

In the chapter on the Strength of Hydrostatic Presses, Professor Barlow's investigation was, as is now well known, left incomplete; and he even drew a logically false conclusion from his own formulæ. Since that Dr. Hart, Morin, and others have given correct formulæ for calculating the strength of tubes of considerable thickness; and as a converse corollary, the methods of getting the utmost resistance out of a given total thickness of material have been pointed out. Of all this not one word is said.

The old experiments of resistance to tension—Brunel on hammered iron—stand once more alone in their glory, but not accompanied by one word of notice as to the important facts since his day brought to light as to the extensibility in various directions, and the very different coefficients of ultimate resistance of various forms of forged iron, and in different directions of their mass.

The whole chapter under the high-sounding title of On the Strength of Brick, Stone, Cement, &c., stands just as it did in 1837, or before, and is comprised in *four* pages of the very meagrest sort; but not one word is said of the innumerable experiments that have since been made upon the resistances of Roman and Portland cement, &c., in England; and of various native cements in France and Germany; and of brick, stone, mortars, &c., in all these countries.

Not an allusion occurs to what is by far the most copious and most important train of experiments probably ever made, viz., those upon the

transverse resistances of the whole of the building stones of Ireland, made by Mr. Wilkinson, architect, and published fully ten years ago.

Even the very errors that occurred in the tables of the oldest editions seem never to have been looked at or corrected. Thus, for example, in the tables of specific gravities, which might surely have been well omitted altogether, we have copper set down at specific gravity from 8·607 to 8·785, as derived from the impure metal of the days of Muschenbröek, from which the table dates, whilst it is well known now that the true specific gravity of copper is from 8·921 to 8·952. Nothing is more vexatious than to take out of a table, on the supposition that it is reliable, some bit of false datum like this; hours of after labour are often so wasted.

We earnestly wish, for the sake of the names of those connected with this new edition (so well and honourably known as they are in other ways), that we could have spoken of their work more favourably. The fame of the original author rests on a pedestal not to be injured by any mere heaping up of rubbish around it—even were what is here very incongruously compiled deserving *per se* of that title, which it certainly is not. But it is not by this sort of editing, or rather of book-making, that either the credit of our British engineering science is to be upheld, or the rising school of British engineers duly instructed. Nor is it for us in our own vocation, to let the men of science of the Continent suppose that there is nobody in Great Britain capable of recognizing a higher style of teaching.

What is wanted most with us in England now-a-days, in the way of a new work on resistance of materials, is not any such entangled heaping up of things new and old, clean and unclean, but, as to *data*, some such work as that of M. Love, which endeavours to condense, and discuss, and arrive at certain and sound data, within ascertained limits of maximum and minimum, enlarging the scope of what he has done for iron to all constructive materials, and deducing these from the whole mass of experiments already before the world.—Ed.

PARIS EXHIBITION (BRITISH EXECUTIVE).

Report on Class 53, Group VI.

MACHINES AND MECHANICAL APPARATUS IN GENERAL.

By Robert Mallet, C.E., F.R.S.

(*Continued from page* 314.)

Several well-known forms of turbine are exhibited, as well as that for very high falls by Rhieter, of Winterthur, and the singular floating water-wheels of Colladon, of Geneva. The improvements in turbines now necessarily move in the direction of simplification of parts, so as to cheapen the machine, and make it in its wearing parts more durable. Its principles and methods for proportioning its parts are now well known through the labours of many, amongst whom Fourneyron, whose recent death, in the midst of his labours at the Exhibition, all deplore, will ever be viewed as having borne a most distinguished part. It is an unexpected fact to find that MM. Fossey & Co., of Lasarte, in Guipuscoa, Spain, are amongst the largest makers of turbines in Europe. They produce a list, giving particulars of above 120 turbines erected by them in that kingdom.

Amongst the motors dependent upon the motion of the wind may be mentioned the very simple and ingenious arrangement of wind-mill with movable vanes, acted upon by a peculiar form of centrifugal governor, upon the "systéme Thirion," exhibited in the Parc by the Société Anonyme de Chatelineau, of Belgium.

Amongst the apparatus destined for the elevation of solids, numerous steam cranes, fixed or movable, are shown; none seem to possess very prominent merits of any sort. The finest work of this class shown is the overhead or gantry crane by Cail & Co., employed upon the quay of the Seine, for the landing of heavy pieces for the Exhibition. Amongst the designs for this class of machines is one by Laudet & Co., of much merit for a very good, cheap, and simple form of steam gantry for quarry purposes.

There are very many hoists and lifts for warehouse or hotel, or other like use, some dependent upon chain and gear, others upon direct hydraulic support and lift for the entire elevation, which is here equal to that of the total height of the machinery zone of the building. These lifts are rather toys for popular amusement than objects of interest for their novelty or merits to the mechanical engineer.

In Group IV. of our division of this class the pumps exhibited are almost innumerable, and of every class, from the smallest and commonest domestic pump to the largest machines for supply of towns, drainage, or irrigation.

Centrifugal pumps present little beyond the old models seen in 1862 and often besides. The American centrifugal pump already noticed is an exception, however, as is also a centrifugal pump in the Swiss Annex, in which the central boss of the revolving central piece is so made as materially to reduce the hydraulic coefficient of contraction of the vein of fluid entering the "ears" of the pump at either side. M. Bernay's, of London, construction aims as well at these advantages.

Bastier's chain pump is shown at work; in construction it is not new. It is much to be regretted that upon the present occasion, just as in 1862 and 1855, there is no organization by which the actual duty of the more prominent of these pumps, and more especially of the centrifugal pumps, can be experimentally tested. Such trials would add some valuable and much wanted data to practical hydraulics and would strip away much false pretension, which at present only requires bold utterance to have its effect with the public, and to pass uncontradicted even by the man of science, who feels he is not in a position to give any exact judgment; but this would apply to much more besides, in such exhibitions as these.

To this group belong fire engines. Manual fire engines prove the wide extension they have within the last ten or fifteen years obtained all over the world by the number of exhibitors from nearly every state in Europe. Most of these foreign manual engines are neatly turned out of hand, and dignified with much polished brass, paint, gilding, and varnish. But the forms are never as good as those of our best English engineers, and in some cases the fundamental principles upon which the power of men can alone be to the best advantage applied to a reciprocating handle of a fire engine appear to be unknown. Some of the smaller French bath or pan fire engines may probably possess advantages in relation to the structure of the buildings in the older towns of France, and to their water supplies, that are not apparent to us. Austria shows fire engines with plate-iron cisterns, and in tolerably good proportion. City fire engines, wholly of iron, except the handles, have, however, been constructed in Great Britain and Ireland fifteen years ago.

Several steam fire engines are exhibited. Amongst the chief of which are those from England by Merryweather & Sons, and by Shand & Mason, and one by Goldschmidt, a French maker. These were tried in contest at the Seine Quay, when, after a protracted and well-fought trial, the engines of Merryweather & Sons were declared by the jury the best. Did space permit we should be prepared to point out good grounds to justify that decision, as regards both the design and the performance of those engines.

The archæological student, as well as the mechanical engineer and tropical agriculturist, will examine with interest the photographs by M. Desiré, of Cairo (Egypt), of the ancient apparatus and methods of irrigation, which have latterly been supplanted by steam pumping in Upper Egypt.

We may include in this group machines for the pumping of air. Of centrifugal fans there are innumerable examples; none presenting wide or important departures from known models. The application of a fan under peculiar conditions to supplying blast to a smith's hearth, in such a way as to pass back some of the unconsumed gases of the fire with the air through the incandescent fuel, by Rhieter, of Winterthur, is worthy of examination, and were it practicable, of trial.

Of machines for the transfer of condensed air in large volumes for manufacturing uses the largest example is the blast engine shown by the Société Cockerell of Liège. This is a vertical machine, with the large blast cylinder standing upon the top of the lofty framing of the direct-acting double cylinder engine beneath it. In the design of the cylinders and nozzles of the engine itself are some points of merit; but the general design of this work, though stated to be similar to that by which the Cockerell Company have constructed a large number of blast engines, is such as it is impossible to refer to favourably.

Amongst machines for moving great volumes of air, without any considerable condensation of volume, is the mine ventilator exhibited by the Bochum Iron and Steel Company, of Prussia. There are many other ventilators exhibited.

In Group V. it is impossible to notice here more than a mere fragment of the numerous objects exhibited, which on some ground or other would deserve particularization.

By far the most important and interesting automatic weighing machine is that for grain, seeds, or any other material divided into particles of such a nature and size as to run through tubes or apertures, in the same way as the above substances are known to do. The grain or other material descending along an inclined tube is constantly discharged into one or other of two coffers, which are equilibrated each upon an axis, in such a way that the instant one is filled by the running stream of grain to a given bulk it cants over and discharges, and returns directly to its proper place to be filled again, and so by the other coffer alternately. The axis of each coffer is borne upon one extremity of the levers of a weigh-bridge or compound balance, and this is so adjusted that when it is pressed down by a given weight (namely, that of the full of the coffer of the substance being weighed), but not before, it at the same time releases a detent which permits the coffer to cant, and at the same time registers the fact (upon a counter) that it has canted, *i.e.*, that one cofferfull has been weighed, and so on continuously. The exactitude of the machine seems as great as can be desired, and its action perfect. It could be applied upon any scale, so that cart loads of road metal, or of paving stones, might be thus weighed as well as mustard seed.

M. Rabo, of Guastalla, Italy, also exhibits arrangements for mechanical weighing of grain.

In this class we must not omit to notice the wonderfully delicate Bascule, or weighbridge, fitted for common use, and at a common price, of M. Taurines, which with a man standing on the platform is capable of showing the impulse of his heart at each beat of his pulse. These weighing machines of great simplicity of structure justly received one of the gold medals.

The decimal balances of Tengelin, of Stockholm, and of Butenop, of Moscow, as tending to abridge labour, are worthy of observation. Mechanical apparatus for the measurement of liquids, in the shape of water meters, are numerous, and many of interest, while some few have secured the sanction of considerable practical adoption by water companies, &c.

The Fabrique de Landquart, of Switzerland, exhibit good arrangements for measuring mechanically liquids employed in commerce, &c.

By far the most interesting and ingenious instrument exhibited of this class, however, is the alcoholometer of Messrs. Siemens—an instrument destined not only to determine and register the volume of spirit passed through it, but to determine also the amount of absolute alcohol which it contains.

The gas meters, both British and foreign, are exhibited in great numbers, and are nearly all of great average, and some of very high, merit. It would exceed much our space, however, to go into the details of these, which would involve much explanation, scarcely possible, without illustrations, to make intelligible.

The steam pressing or forging machine of M. Hassal, as exhibited by Egels in the Austrian division, was placed in this class, though more properly belonging to that of machine tools. It is matter for regret that this tool, destined hereafter to play a great part in the working of iron, as well as of other malleable metals, was

not shown at actual work. The general arrangements by which a prodigious pressure, obtained through the medium of the hydraulic press, is made the substitute for the blows of the steam hammer, will be tolerably obvious on inspection of the machine. To explain its full value as a tool for working into new forms wrought iron at high temperatures would involve much introductory remark in relation to the molecular properties of metals. The pressure forging machine will hereafter enable wrought iron to be given forms, by the aid of hollow dies or swages, which are impossible by the percussive action of the steam hammer, and so to extend the wide domain of existing uses of forged iron in structures such as iron ships, engine framing and parts, artillery, &c.

Amongst objects intended to constitute the organs or *parts* of machines, the toothed wheels exhibited by Piat & Co., France, which are cast without the use of wood models by the aid of moulding machinery, deserve the highest commendation and the careful observation of every iron founder. The forms of the teeth of all these various sorts and different sizes of toothed gear are excellent; and the mutual adaptation of these in wheels and pinions, whether bevel or spur, in endless wheels and worms, &c., &c., perfect, but the perfection of execution of the castings themselves is still more remarkable, and indeed can scarcely be exceeded.

Leather belts also, as organs of machines, are widely exhibited and shown in great perfection and in the very largest sizes. Those of Scellos, France, of the very largest size and thickness, for the transfer of the whole power of first movers, formed of leather wire woven together, the integrant straps being placed on edge, are worthy of the attentive examination of the mechanician.

No more remarkable nor probably, as regards its future, more important object is exhibited on this occasion than is the arrangement of M. Hirn for the transfer to great distances of power and motion by the rapid transfer of an endless wire of small diameter over large and peculiarly constructed pulleys, one of which is at the transmitting, and the other at the receiving, end of the telodynamic range. At first sight, or to the casual observer, M. Hirn's arrangement—which may be seen at work in the Parc, where it transmits, through a wire not thicker than a large pencil, about 25 horse nominal power to actuate pumps (supplying the building) at a distance from the source of power of several hundred feet—appears but one form of the old well-known strap or belt with its strap pulleys; and it is so much, but it is also much more, for it involves and is based upon a *principle* which had not before been made available for the transmission of power to great distances. This may be popularly stated thus: when *work*—that is, pressure and *motion* together—has to be transmitted by tension through a cord or fibre, such as a wire or rod of iron or other material, a given amount of work in a unit of time can be always transmitted through a *smaller* and *smaller section* of fibre or rod, in proportion as we *increase* the velocity with which a point in the transmitting fibre or rod travels, so that the product of the pressure and of the velocity with which it acts to produce work shall be constant.

For example, a cylindrical bar of iron of an inch diameter, we may say, can transmit a pull of 10 tons through itself without stretching; and if that pull being always on the rod, it passes a given fixed point at the rate, let us say, of 5 feet per second, then at that point the rod is transmitting work at the rate of 10 tons × 5 feet = 50 foot tons.

But if we have another rod of the same material of only $\frac{1}{10}$ of an inch in diameter, which will therefore have $\frac{1}{100}$ the cross section of the 1-inch bar; this will bear, without stretching permanently, the $\frac{1}{100}$ of 10 tons, or $\frac{1}{10}$ of a ton. Now if this last rod transmits this pressure of $\frac{1}{10}$ of a ton past a given fixed point at a rate 100 times as fast as in the former instance, then the work transmitted by the small and the great rod shall be equal in equal times; or,

1-inch bar, 10 tons × 5 feet = 50 foot tons.
$\frac{1}{10}$-inch bar, $\frac{1}{10}$ ton × 5 feet × 100 = 50 foot tons.

But this last is a mere wire, and will be light and flexible enough to be passed round the rims of large pulleys at such high speeds, and by friction on these rims (friction for equal pressures being the same at all velocities within large limits) to transfer the work to their axes in way of rotation. Thus, theoretically the power of the largest steam-engines in the world might be transmitted to any distance through a human hair. The practical limit with steel wire is found, however, about when the diameter is reduced to from $\frac{2}{10}$ to $\frac{3}{10}$ of an inch. The limit of velocity is only that at which, by centrifugal force, the pulleys might become deranged or unsafe.

M. Hirn has, by this beautiful and simple adaptation in practice of a dynamic principle, succeeded in transmitting the power which drives large factories to great distances; in some cases as far as across the Rhine near Schaffhausen.

In general the objects exhibited of every group into which we have, for the purposes of this report, divided Class 53, indicate to the skilled observer more exact knowledge and more heedful adaptation of *principles* upon the part of constructors than in 1862.

There is also obvious an almost universally advanced standard of execution, owing to improved manual skill, but far more to improved and better adapted and often special machine tools.

The Class can scarcely be said to be characterized by any one great novelty, or by any invention not before exhibited, likely to mark an epoch in industrial future history.

The great lesson to be learnt from the examination of this, as of several other classes in the Exhibition of 1867, and which it is important for all Englishmen to ponder well upon, may be expressed in the very same words in which the reporter expressed his conclusions upon the class of prime movers exhibited in London in 1862:—

"It is not to be concealed, however, that the advances made by us in Great Britain during the past decade have not been commensurate to those achieved abroad. France, Prussia, Belgium, and America are now, and in the order named, fairly 'our rivals' in this that we have been wont fondly to suppose was our national speciality and peculiar apostleship. France, in her superior system of technical education for her working men, with the sound and thorough science of her technical professors and leading engineers; Prussia, with her own well-founded system of *bread-knowledge education of her working classes*, their sober and thrifty habits—all bid us beware lest in this great race the tortoise beat the hare at last."

That which was thus true in 1862 is far more widely and thoroughly true in 1867; and as has lately been well said, "so sure as knowledge is power, and the want of it weakness," whether to individual or nation, so had we best bestir ourselves mightily and promptly in Great Britain, lest that which was once true of us, may be no longer true in ten years hence.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

ON THE AGE OF THE HÆMATITE IRON DEPOSITS OF FURNESS.

By E. W. Binney, F.R.S., F.G.S.

The great value of the vast deposits of hæmatite iron ore found in the carboniferous limestone of North Lancashire, and in a similar position near Whitehaven, in Cumberland, renders any information as to the date of their formation of considerable importance. There is no doubt that the carboniferous limestone was first formed in most instances. Hollows were then made by some agency, whether by aqueous or atmospheric, or both agencies, it is not necessary here to inquire; but most of the cavities bear evidence of some erosive action, their sides being more like old valleys or water-courses than simple fissures. The next question to be considered is, When were these hollows filled with the iron ore? No one who has investigated the subject would estimate their age so late as the date of the magnesian limestone, but some eminent geologists have supposed them to have been formed during the Lower Permian period, whilst others have adduced reasons for believing that they had been formed during the Carboniferous epoch. There is very little doubt but that large deposits of iron have been met with in both these formations, some of Carboniferous and others of Permian age, but our present inquiry is the geological age of the hæmatite iron ores of Furness.

In two memoirs printed in the Transactions of this Society, namely, in volumes viii. and xii. (second series), he had described deposits of hæmatite iron ore, and given his reasons for believing that they had their origin during the Carboniferous epoch, and were deposited in erosions of the mountain limestone in some instances, or in others interstratified in regular beds in the lower coal measures like seams of coal. Long after his papers had been printed, Sir R. I. Murchison, Bart., F.R.S., and Professor Harkness, F.R.S., in a memoir on the Permian rocks of the North-West of England, printed in volume xx. of the *Quarterly Journal of the Geological Society*, at page 152, say, "The mode in which that valuable ore of iron *hæmatite* is found deposited in pre-existing cavities of the carboniferous formation, and sealed up by crab rock (Permian breccia) is a matter of great geological interest. Joints, fissures, and caverns were doubtless formed in the older rocks antecedent to the deposition of the Permian strata, and in these the ores of iron, so widely diffused throughout the Permian rocks, have in this portion of the north-western region assumed the character of hæmatite. This circumstance justifies the inference that these hæmatite ores are the result of an agency which ushered in the Permian epoch. The earlier rocks of both England and Scotland are strongly impregnated with iron, their composition consisting principally of silica and an oxide of this metal. This latter substance originated from the same source which, during the commencement of the deposition of the Penrith sandstones, filled up the fissures in the carboniferous limestone. This conclusion is applicable not only to the Ulverstone district but also to that of Cleator, south-east of Whitehaven, where valuable deposits of hæmatite are also obtained from the cavities and fissures in the carboniferous limestone, which at one time was here covered over by an extension of those Permian breccias and sandstones, now forming an escarpment a short distance west of Cleator Moor. This inference concerning the Permian age of the hæmatite had been arrived at by Professor Phillips, who, in a communication to the British Association, of which a short abstract was published (Report of Brit. Ass. 1858, Trans. Sects. p. 106), illustrated his opinions by maps and drawings."

The authors of the paper illustrated their views in a section from Park to Furness Abbey, shown in a woodcut exhibiting two vertical fissures in the limestone rock, filled with hæmatite and covered up with breccia or crab rock. Now this undoubtedly shows that the limestone rock was first formed, then that the fissures or erosions were made and subsequently filled with hæmatite. But at what time the latter process took place, whether during the Carboniferous or Permian epoch, no evidence is adduced by the authors further than that the beds of hæmatite are there covered up by Permian breccia, and some of the latter has been introduced into the fissures. It has been generally supposed by geologists that at the close of the Carboniferous epoch great convulsions took place in the earth's crust, and large quantities of iron were ejected from its interior. Now, the three authors previously named are recognized authorities on the age of hæmatite iron ores, and their opinions deserve great attention. When his papers were written, conclusive evidence could only be given of the age of the hæmatite iron of Ipstones, in Staffordshire, which was clearly interstratified in the lower coal measures between the Rough Rock or Upper Millstone of Professor Phillips and the Geological Survey and the Gannister coal. Some years since, Mr. Bolton, of Swarthmoor, near Ulverstone, showed him, amongst other fossils, a beautiful specimen of *Sigillaria vascularis*, exhibiting both its external characters and internal structure, quite as perfect in every respect as the specimens found in the Gannister or Hard coal at Halifax or the Bullion seam of Burnley, all converted into hæmatite iron. At that time no doubt existed in his mind of its having come from one of the Furness iron mines, but Mr. Bolton could give him no proof of the exact locality where it was found. At a meeting of the Manchester Geological Society, held on the 30th May, 1866, he gave his opinion of the value of this fossil as indicating the carboniferous age of the hæmatite iron ores of Furness. These specimens have been kindly lent him by Mr. Swainson, of Newland, their present owner, and were exhibited on the table for examination. With them were some other interesting specimens from the cabinet of Miss E. Hodgson, of Ulverstone, a lady well known for her acquaintance with the geology of Furness, and who procured the specimens now exhibited from the Water Blain Mines, west of the Duddon. They do not exhibit their external characters so well as Mr. Swainson's specimens do; but one is a *Stigmaria*, the root of *Sigillaria*, and another

a *Lepidodendron*, two common coal plants, which indicate the carboniferous age of the deposit in which they were found as clearly as any fossil organic remains can do. There is no doubt about the locality of Miss Hodgson's specimens. They came from the Water Blain Mines, and plenty more may be obtained from the same place. They are all converted into good hæmatite iron, that substance having metallized them in a similar way as we find plants in the coal measures converted into the carbonate of the protoxide or the bisulphide of iron or carbonate of lime.

It was not his intention here to attempt to give any explanation of the process by which the original ligneous structure of the plant has been removed and replaced by peroxide of iron; that is a subject better fitted for the chemist than the geologist.

Now the discovery of common coal plants not only embedded in but actually formed of hæmatite iron, surely indicates the carboniferous age of the deposits in which they are now found as clearly as it well can be; for the plants must have been floated in with the water which brought the iron, or else they must have fallen into the cavities when such were open at the top, and the iron was in a soft state. Of course, the occurrence of such fossil plants as *Sigillaria*, *Lepidodendron*, and *Calamitis* occurring as they do in beds, from the lowest to the highest carboniferous strata, would give little evidence of any particular part of that epoch; but the *Sigillaria vascularis*, so far as yet known, is confined to the lower coal-field, not far in geological position from the Ipstones hæmatite previously alluded to, and the valuable clay band ironstones now wrought at Hazelhead, west of Penistone.

The deposits of hæmatite in Furness and Cumberland, found in hollows of the carboniferous limestone, and covered up by till, or "pinel," as it is locally termed, or more rarely by Permian breccia, are so much alike in all their characters that if the origin and age of one of them are clearly proved those of the rest must follow almost as a necessary consequence.

W. Brockbank, F.G.S., agreed with Mr. Binney, that the fossils now exhibited were valuable illustrations of the age of the deposits of hæmatite ore in the Furness district; but they did not afford any evidence of their origin, and were merely brought there with the other alluvium, and deposited with the iron ore, in the cavities of the limestone. The Cumberland district afforded better opportunities for studying the origin of these ores. True veins of hæmatite occur in the older slates, porphyries, and syenites of the Lake district. Red pike derives its name from the presence of veins of this ore, which gives the mountain its ruddy aspect; and iron appears to have been smelted near it in the time of the Romans. On Black Comb, Dent Fell, and in the valleys above Ravenglass, veins of hæmatite occur in the older rocks, and are worked to a small extent, and the ore carted down to the railway. The richest deposits, however, occur in those places where clay slate is overlaid with other rocks, and principally in the carboniferous limestone.

In the Cleator district a narrow band of limestone, resting upon the clay slate, curves around the flank of Dent Fell, and in this narrow zone most of the iron ore mines of the Whitehaven district occur. The ore is found generally in large masses or pockets, in the body of the limestone, sometimes in contact with the clay slate, and at others filling cavities and clefts to the surface, and covered by alluvium. The limestone is at places overlaid by whirlstone or millstone grit, and the ore occurs both above and below this rock. In one remarkable mine the ore fills a large cavity in the limestone, and is covered by whirlstone, which forms a perfectly even roof over a large area. Where the hæmatite occurs near the clay slate, it is generally hard and crystalline, and it is much softer and less silicious where it appears to have been deposited in the limestone, or by alluvium, causing a classification in this district into hard and soft ores, whereas in the Furness district they are generally of the soft kind.

In considering the origin of these ores, we must go back to the time when the limestone and associated rocks of the Carboniferous period had been formed at the bottom of the sea, and were raised therefrom by some vast force of upheaval which would naturally cause great denudation and break up the rock into clefts and fissures. This would appear to have been a time of great volcanic, or at any rate of metalliferous activity; and the two mountains of Dent Fell and Black Comb bear evidences of having been very active centres of this action, and their upheaval may very possibly have been connected with the eruption of the hæmatite ores. It is therefore probable that during the early part of the Carboniferous era, the hæmatite ores were formed by these agencies, and by the denudations, which were vast and probably frequent, were partly removed and deposited in clefts and cavities wherever they were carried. The fossils produced by Mr. Binney point also to this period in the Furness district, as that in which the ores were carried into the cavities they now fill. The two mountains of Dent Fell and Black Comb appear to stand as a line of hæmatite ore mines, the country both between them and on their line north and southwards being dotted over with mines, and being most productive in their immediate vicinities. At Hodbarrow, immediately at the foot of Black Comb, occurs one of the richest mines yet discovered. It lies in a cleft of limestone, and appears to be more like a lode or vein than a deposit, and is immediately upon the shore of the Duddon estuary. This vein has been found on the south shore of the estuary just opposite, and it is fully believed that it is continuous through the sea. The richest mines of the Furness district are also immediately to the south of this point. The principal mines of Furness are deposits, as shown by Mr. Binney, and the evidence of the Cleator district would point to Black Comb as a very possible source for their origin.

In the Cleator district the Carboniferous strata are at places overlaid unconformably by the Permian of St. Bees Head, and in the lower red sandstone, underlying the magnesian limestone and conglomerate, are found many fossil plants, which are generally coated with red ore instead of carbonaceous matter. The conglomerates of St Bees and Rougham Point also contain pebbles of hæmatite; both facts pointing again to denudation of hæmatite ore during the Permian era.

INSTITUTION OF CIVIL ENGINEERS.

December 3, 1867.—The first paper read was, "Description of the Victoria Bridge, on the line of the Victoria Station and Pimlico Railway," by Mr. W. Wilson, M. Inst. C.E.

It was stated that this bridge crossed the River Thames about 150 yards to the eastward of the Chelsea Suspension Bridge, at a point where the width of the waterway between the embankment walls was 740 feet. It consisted of four segmental wrought-iron arches, each having a span of 175 feet at the springing, with a rise of 17 feet 6 inches, and a clear headway of 22 feet above Trinity high-water level. At the northern end there was a land opening of 70 feet span crossing the Grosvenor Road, and on the southern shore there was a corresponding opening of 65 feet span crossing the wharves of the Brighton Railway Company.

In the first place, the gravel was dredged out of the bed of the river, down to the clay substratum, for a breadth of 100 feet, and extending across the entire width of the water. Cofferdams, constructed of two rows of whole timbers, walled and strutted in the usual manner, were then driven 4 feet below the level of the intended foundation. When the inclosed area was cleared of water, the clay was excavated to a depth of 40 feet below Trinity high-water level. The space to be occupied by the foundations was next surrounded by permanent sheet piles driven to a depth of 8 feet below the lowest foundation level. Within this sheeting a bed of cement concrete, 4 feet in thickness, was formed, and on that the masonry of the piers was commenced, the concrete being afterwards carried up to the top of the sheet piles round the entire circumference of the piers. From the footings up to the level of 4 feet below low-water, the piers were built entirely of brickwork in lias mortar; thence to high-water level they were faced with rock-faced Portland roach stone, with one through course half way up. The core, or backing, was composed of pavior bricks, set in lias mortar, and the cutwaters, caps, springers, and other masonry above high-water were of tool-dressed Bramley Fall stone. The width of the piers at the springing line was 12 feet 4 inches, and from the extrados of the arch to the level of the cornice the width was 10 feet.

The superstructure of each of the four principal openings consisted of six wrought-iron arched girders, springing from cast-iron bed-plates fixed to the masonry. Horizontal girders, resting on the piers and on the abutments, and rivetted to the arch near the crown, formed the longitudinal bearers for the roadway. The spandrils, or intermediate spaces between the arched ribs and the horizontal girders, were filled in with a wrought-iron framework radiating from the arch; and between the horizontal bearers cross girders, for carrying the roadway, were fixed at distances averaging about 3 feet apart.

A detailed description was then given of the ironwork of one of the principal spans, that of the others being precisely similar: from this it appeared that all the six ribs of which each arch was composed were alike in construction, but varied in sectional area: they were I-shaped, the top and bottom tables and the central web being composed of flat plates, connected together longitudinally by angle irons, and vertically by T-iron stiffening pieces. The two middle ribs, which might each have to carry half the load on one line of rails, had each a sectional area of 80 inches; the ribs intermediate between these and the outer ribs had each a sectional area of 71·2 inches, while the sectional area of each of the face ribs was 53·4 inches. The horizontal girders were continuous over the entire length of the four principal openings, and in the centre of each pier a stiff expansion joint was provided, for the purpose of equalizing the strains under different temperatures. The joints were made and the bolts screwed up at a mean temperature of 60°; and the girders, which rested on bed-plates on each side of the open joint, were perfectly free to expand or contract, the continuity of strain being always preserved by the elasticity of circular vulcanized india rubber washers, two such washers being provided to each bolt.

A segmental cast-iron shoe was bolted to the end of each rib, and rested in a corresponding concave bearer, working loose in a cast-iron frame fixed to the masonry, and provided with wrought-steel keys and cotters, for adjusting the arched rib in position. By this arrangement the whole compressive strain was distributed over the entire sectional area of the arch, whatever the state of the temperature. Each pair of ribs and horizontal bearers were connected together, so as to form, as it were, the two into one box-girder. In addition, there was a complete system of vertical and transverse bracing and trussing to both the girders and the spandril filling.

The total cost of the bridge, including the land arches and abutments, was about £84,000. The superficial area of the roadway, between the parapets, being 31,690 feet, the cost per square foot was £2 13s.; while the total length being 930 feet, the cost per lineal foot was £45 3s. Only twelve months were occupied in the erection of this important structure.

The works were designed by Mr. Fowler (President Inst. C.E.) and were carried out under his supervision by the author. Mr. John Kelk, M.P. (Assoc. Inst. C.E.), was the contractor, and the ironwork was sublet to Messrs. Bray and Waddington; the wrought-iron work was supplied by the Monkbridge Iron Company, and the cross girders and angle-irons by the Butterley Company.

After the arches were erected and the supports were removed, the ironwork was subjected to severe tests, by loading each arch with a moving weight of 350 tons, placed on the two lines of way, being equal to a load of one ton per lineal foot on each pair of rails. Commencing at the north end, the load was placed on the 70-feet openings, extending over the abutment up to the centre of the first arch; the deflection of the 70-feet girders was 0·48 of an inch in the centre, the greatest deflection of the arched rib was 0·58 of an inch at a point 60 feet from the abutment, and 0·38 of an inch at the crown, and the horizontal girder showed a deflection of 0·72 of an inch at 60 feet from the abutment; while a rise was produced in the adjoining arch of 0·12 of an inch at the crown, the third and fourth arches showing no movement. The load was next moved over the entire span of the first arch, when there was a deflection of 0·71 of an inch at the crown, and of 0·56 of an inch at points 35 feet on each side of the centre; at the same time the deflection of the horizontal girder was regular throughout its entire length, commencing with 0 over the piers and increasing gradually to 0·71 of an inch at the centre; the adjoining arch, which was unloaded, showed a rise in the centre of 0·16 of an inch, and at 30 feet nearer the load of 0·17 of an inch; the horizontal girder also rose 0·24 of an inch midway between the pier and the centre of the arch, but no change was perceptible in the third and fourth arches. The load was then passed on to the centre of the first pier and extended from crown to crown of the first and second arches, when a depression of 0·41 of an inch was produced at the crown of each arch, and of 0·36 of an inch and 0·24 of an inch in the horizontal girders midway between

the piers and the centres of the arches. The second arch was then subjected to the whole strain, and subsequently the third arch. The loads were then removed, and a train of engines, weighing 1 ton per lineal foot and 175 feet in length, was run at full speed over one line of way; this produced deflections of 0·40, 0·48, 0·45, and 0·45 of an inch in the four arches respectively. After the experiments were completed, the permanent set was ascertained to amount only to 0·10 of an inch in the first and second arches, and to 0·12 of an inch in the third and fourth arches. In conclusion it was remarked that every part of the ironwork took its fair share of duty, and that the extreme strains, produced by the most unfavourable combination of circumstances, in no case exceeded 4½ tons per inch of section.

The second paper read was, "On New Railways at Battersea, with the widening of the Victoria Bridge, and approaches to the Victoria Station," by Mr. C. D. Fox, M. Inst. C.E.

The system of railways, designed by Sir Charles Fox. M. Inst. C.E., in the year 1862, for the purpose of improving the access to the Victoria Station, by providing additional lines, and avoiding the sharp curves and steep gradients of the then existing railways, comprised:—The widening of the Victoria Station and Pimlico Railway, and of the Victoria Bridge over the Thames; the high-level line from the south end of the Victoria Bridge to near Clapham Junction, with a branch to the Wandsworth Road; the diversion and raising of the West End and Crystal Palace, and West London Extension Railways, the Longhedge Junction, and the two low-level lines from the Victoria Bridge to Stewart's Lane; and the connecting link between the London and South-Western and the London, Chatham, and Dover systems at Clapham Junction.

In widening the Victoria Station and Pimlico Railway, the chief work was the removal of the retaining wall from one side of the existing line—an operation of some difficulty, from the excellent character of the concrete and brick-work originally used, as on account of trains so frequently passing blasting could not be employed. A girder bridge was successfully substituted in place of an arch over the line, by cutting away a narrow strip of the arch, and inserting one girder at a time.

It was originally intended to construct an independent bridge over the river Thames, to carry three lines of way for the London, Chatham, and Dover traffic; but it having been determined to add, at the same time, a third line for the London, Brighton, and South Coast Railway Company, it became necessary to make arrangements for joining up the new work with the Victoria Bridge. The new bridge, in common with the original one, consisted of four river spans, of 175 feet each, having arched ribs, with a rise of 17 feet 6 inches, and of two land openings, carried by plate girders, the one of 70 feet, the other of 65 feet span. Its width, from the outside of the original bridge to the parapet, was 100 feet, giving, with the old work, one structure 132 feet 6 inches wide between the parapets. The total length of the piers and abutments just below the springing was 158 feet. The excavations of the abutments were got out by means of coffer-dams, the inclosed area being afterwards covered with cement concrete, 3 feet in thickness, then with brickwork in cement, also 3 feet in thickness, surmounted by outside and cross walls of brick in cement, the pockets being filled with lime concrete. In consequence of the proximity of the original bridge, it was impossible to drive the coffer-dams so as to include the whole of the work, and a portion of the face was therefore carried on strong cast-iron girders, put in at low-water mark, resting at one end on the old and at the other on the new work. By the use of cement, and the care taken to keep the joints thin, the abutments, though bonded up with the old work, had not shown the least sign of movement. The foundations of each pier were carried down by means of four cast-iron cylinders, each 21 feet internal diameter; temporary wrought-iron cylinders, 19 feet in diameter, being used for the top. About 100 tons of kentledge were used in sinking them; this was laid upon stages slung within the cylinders, as being less liable to tilt them than when placed outside, and more easily thrown off when the requisite depth was reached. The cylinders were all sunk to an average depth of 45 feet below Trinity high-water mark, of which 13 feet were into the London clay, the total time occupied in sinking being on an average eight days. The cylinders were filled with cement concrete for a depth of 12 feet, and then with brick in cement up to low-water mark. The brickwork was then tested, and afterwards the masonry was commenced. The stonework face, between the cylinders and forming the connection between the old and the new work, was carried on strong cast-iron framework.

The superstructure of each of the river spans was precisely the same, and consisted of eight main ribs, with provision for a ninth. Of these, the rib nearest the existing bridge was only one-half the strength of the others, which were each calculated to carry a single line of way. These arched ribs were of wrought iron, 3 feet 4 inches deep, and the flanges were 18 inches wide; but for 38 feet in the centre of the span they merged into one with the horizontal girders, thus giving a total depth at the centre of 4 feet 6 inches. The flanges of the ribs gradually diminished from a thickness of 3 inches at the centre to 1½ inch at the springing, the webs being of plates ¾ of an inch thick throughout. The sectional area of the rib at the centre was 166·9 square inches, or deducting rivets, 142·5 square inches; the sectional area of the rib at the springing was 102·4 and 86·5 square inches respectively. The horizontal girder was 4 feet 6 inches deep, with flanges 18 inches wide, and was continuous throughout, the whole bridge being rivetted up for a length of 913 feet. It was firmly connected with the cast-iron standards at the piers and at the abutments, in order to obtain the full advantage of continuity for the land spans, and was anchored by a plate running from the top flange down to the cast-iron skew back. The main ribs were braced by transverse girders and by vertical diagonal bracing; the four middle ribs being further cross-braced horizontally.

The calculations of the strains, from which the superstructure was designed, led the author to the conclusion, that whilst cast iron was the best material for arched bridges of single spans, similar bridges of several spans, having piers whose perfect stability under horizontal stress could not be relied on, were under certain circumstances exposed to tensile strains which rendered the use of wrought iron most desirable. The bridge was severely tested on several occasions by Major Rich, R.E., on behalf of the Board of Trade. Each rib, where practicable, with the exception of those adjoining the original bridge, was tested with eight of the heaviest locomotives and tenders, weighing 360 tons, or thereabouts, which were allowed to stand on, and also to run over at speed; and the whole structure was then tested with twelve locomotives and tenders, weighing 530 tons, or thereabouts. The ribs deflected uniformly, when fully loaded, to the extent of $\frac{7}{8}$ of an inch at the centre; the corresponding ribs in the adjacent spans at the same time showing a rise of $\frac{1}{8}$ of an inch at the centre. The girders over the land spans, when fully loaded, showed a deflection in the centre of ½ an inch. The cross-girders, when a pair of driving wheels rested exactly upon them, showed a deflection in the centre of $\frac{3}{8}$ of an inch. The permanent set in each case was scarcely appreciable. Careful observations had been made for nine months as to the effect of changes of temperature upon the structure. This effect was limited to a rise and fall of the crown of the arches, amounting to a maximum of 1½ inch, and a movement at the free ends of the land arch girders of $\frac{1}{16}$ of an inch.

The total cost of the bridge, including the land spans, had been £245,000, which was equal to about £2 13s. per superficial foot of space covered, or about £38 per lineal foot of single line. The bridge was completed in seventeen months; the whole of the ironwork having been supplied and fixed by Messrs. Ormerod and Grierson, the sub contractors.

The high-level line of the London, Brighton, and South Coast Railway Company, with a branch line from the Wandsworth Road, consisted mainly of a viaduct of brickwork, which was described. The bridges were of a heavy character, comprising eighteen spans in wrought iron, ranging from 26 feet to 150 feet, three spans in cast iron of from 60 feet to 70 feet, and nine spans of brick in cement. The bridge over the London and South-Western Railway had a central span of 149 feet and two side spans of 47 feet each, and had two main girders of lattice construction, continuous throughout. The centre span was erected without the use of scaffolding, by putting together the bottom flange and lifting it into its place, supporting it by temporary truss-rods, and then erecting the remainder of the girder upon it, inserting the tension bars from either end till they met in the middle.

An adjoining bridge, of 120 feet span, was of similar construction. The main girders, weighing 106 tons each, were built on the viaduct, and, when put together complete, were each rolled over into their places during the night, an operation occupying but four hours.

The other lines of this system were afterwards described, and it was stated that these works, which were three years in progress, comprised a length equal to 9 miles of double line, of which 5 miles were on viaduct, and had cost for works only, including the bridge over the Thames, the sum of £910,000. The high-level line of the Brighton Company, which was entirely on viaduct, had cost, including permanent way, stations, and signals, and the numerous heavy bridges, £45 per lineal yard of double line. The whole of the works had been executed from the designs and under the superintendence of Sir Charles Fox, M. Inst. C.E., and the author; Mr. Edmund Wragge being the resident engineer. The contractors were Messrs Peto, Betts, and Crampton, Messrs. Lucas Brothers, and Messrs. W. & J. Pickering, Mr. J. Heywood, jun., executing the ironwork for the Brighton Company.

It was announced that the discussion upon Mr. Wilson's paper, "Description of the Victoria Bridge, on the line of the Victoria Station and Pimlico Railway;" and upon Mr. Fox's paper, "On New Railways at Battersea; with the widening of the Victoria Bridge, and Approaches to the Victoria Station," which had been commenced, would be continued at the next meeting, Tuesday, December 10.

At the monthly ballot, the following candidates were balloted for and duly elected, as Members—John Hallen Abbott, Edmund Cooper, George Gordon, Francis Hawkes, Samuel Waite Johnson, David Logan, William Low, John Stevenson Macintyre, John Mackinlay, Walter M'Clelland, William Menelaus, John Preston, Thomas David Roberts, Anthony Sherwood, John Frederick Spencer, William Henry Wheeler, John Sheldon Wilkinson, and George Hustwait Wright; and as Associates—Frederick Edwards Archer, Benjamin Baker, Lieutenant Gordon Bigsby, R.E., Herbert Bland Browning, Thomas Long Colley, Charles Davies, Herbert Louis Augustus Davis, William Henry Delano, Thomas Eastman, John Marshall Easton, John Hyde Edwards, Captain Charles Wilson Faber, Charles Gandon, John Howard, Thomas Manson Rymer Jones, James Livesey, William Luke, Thomas Edward O'Brien, Edward Charles Patterson, William Smallpiece, William Tijou, Henry Eltze Victor, and James Birdsall Walton.

A report was brought up from the Council stating that, under the provisions of Section IV. of the Bye-Laws, the following candidates had that day been admitted students of the Institution: William Berrell, Jabez Church, jun., Edward Crompton, Frederick Harry Mort, Thomas Reynolds, William Tweedie, and Antonio Augusto Vieira.

THE ANNUAL GENERAL MEETING.

DECEMBER 17, 1867.—The council in their report stated that it was a source of gratification that the interest taken in the ordinary general meetings by the members of all classes continued to increase. It would be remembered that a principal, if not the primary motive, which led to the establishment of the Institution, was to afford an opportunity for the free and mutual interchange of individual observation and experience in the various branches of engineering. This object had been steadily kept in view during the fifty years which had elapsed since the foundation of the Society; and it was satisfactory to observe that the value and importance of the original communications, and of the discussions, had been fully sustained.

The premiums awarded for some of the communications brought forward last session (and which were presented after the reading of the report), included Telford Medals and Telford Premiums of Books to Messrs. J. T. Chance, M.A., and E. Byrne; a Telford Medal to the Astronomer Royal, F.R.S.; a Watt Medal to Colonel Sir W. Denison, K.C.B., R.E.; a Watt Medal and a Telford Premium of Books to Mr. John Bourne; Telford Premiums of Books to Captain W. H. Tyler and Messrs. W. H. Preece and W. A. Brooks; and the Manby Premium of Books to Mr. C. D. Fox. It was noted, that Colonel Sir. W. Denison, Captain Tyler, Mr. W. A. Brooks, and Mr. W. H. Preece had previously received Telford Medals from the Institution. In the adjudication of the premiums, Mr. W. H. Barlow's description of the Clifton Suspension Bridge was not taken into account, the author being a member of council; but the thanks of the Institution were eminently due to Mr. Barlow for his interesting communication, and for the suggestions he had made in regard to the materials to be employed, and the principles to be adopted, in bridging wide spans which led to so useful and practical a discussion.

The record of these papers and discussions was contained in volume xxvi. of the Minutes of Proceedings, for the session 1866–67, which had been issued to the members in a complete form. The publications of the Institution were at present limited to the printing of the papers and the reports of the discussions upon them. But the members were reminded that they had been invited to contribute, not necessarily for reading at the meetings, the details and results of any experiments or observations on subjects connected with engineering science and practice, for the purpose of forming an Appendix to the Minutes of Proceedings.

It was stated that many circumstances, beyond the control of the council, had prevented a satisfactory conclusion being arrived at, as to the plans that ought to be adopted for providing additional accommodation for carrying on the business of the Institution. Having regard, however, to the increase in the number of members of late years, and the fuller attendance at the meetings, it was trusted that the subject would receive the early consideration of the new council.

The establishment of a class of students, to be attached to the Institution, but not to form part of the corporation, in lieu of the old class of graduates, was next touched upon; and the mode of admission to and the privileges to be enjoyed by this new class, as set forth in the by-laws adopted at a general meeting of members in June last, were detailed. Although not specifically mentioned in the rules, it was contemplated to organize supplemental meetings for the reading and discussion of papers by the students, and possibly also for the delivery to them of lectures upon special subjects. Already seventy-eight students had been enrolled, and the number was likely to be still further increased. The graduate class had ceased to have any existence in the Institution.

Having been informed that a petition had been addressed to the Queen in Council for the grant of a charter of incorporation to a "Society of Engineers," the council of the Institution unanimously arrived at the conclusion that, both in the interests of the profession and of the Institution, it was advisable to present a counter-petition against the grant of a second charter to the same profession, especially to a metropolitan society dealing, or proposing to deal, with precisely similar objects. The petition of the Institution was given at length in the report. A deputation from the council was subsequently received by the president of the Board of Trade; and after the matter had been fully considered by the lords of her Majesty's Council, the "Society of Engineers" was informed that their lordships could not recommend the grant of a royal charter of incorporation to that Society, under a name which was liable to be confused with that of "The Institution of Civil Engineers."

During the past session 48 members and 79 associates had been elected, while the deceases, resignations, and erasures together amounted to 33, leaving an effective increase of 94, or at the rate of 7·02 per cent., on the present number of members of all classes. There were on the books on the 30th of November last, 18 honorary members, 589 members, and 826 associates, making a total of 1433, exclusive of students. The gross numbers at intervals of five years for the last quarter of a century, commencing on the 30th of November, 1842, stood thus: 525, 610, 745, 835, 1000, and 1433, the actual increase in each of the periods referred to being 85, 135, 90, 165, and 433 during the last five years.

The deceases announced during the year had been: Dr. Michael Faraday and the Earl of Rosse, honorary members; Nichol Baird, John Cass Birkinshaw, William Carpmael, James Combe, Alexander Gibb, William Gilbert Ginty, James Cramond Gunn, Robert Hawthorn, Edward Humphrys, Parkin Jeffcock, Alfred King, George May, Auguste Perdonnet, and James Cobby Street, members; John Bethell, Christopher Joseph Cato, Edward Magdalen Joseph Delaney, Frederick Samuel Homfray, Captain Mark Huish, Edward Loysel, William Jopling Nesham, Thomas Richardson, Ph.D., Lieut.-colonel William Drummond Alexander Robertson Short, R.E., and Henry Stone, associates.

With respect to the sources of income, and the way that income had been disbursed, a brief summary of the statement of Receipts and Expenditure for the year ending the 30th of November, 1867, showed that the subscriptions and fees (exclusive of the Building Fund fees) had amounted to £4513 6*s.* 6*d.*, the interest on investments on the general account to £484 5*s.* 8*d.*, and the miscellaneous receipts to £548 7*s.* 4*d.*, making together £5545 19*s.* 6*d.*; while the Building Fund fees and dividends had realized £844 1*s.* 7*d.*, and the Trust Funds £371 15*s.* 5*d.*, bringing up the gross receipts to £6761 16*s.* 6*d.* In the same period the disbursements, including the payments on account of the arrears of the Minutes of Proceedings, had been £4850 8*s.* 8*d.*, and for Premiums under trust £163 10*s.* 3*d.*, while there had been invested on different accounts a sum of £1638 1*s.* 3*d.*, in the purchase of Reduced Three per cent. Annuities. The cash balances exceeded by £109 16*s.* 4*d.* the sums in hand at the same date last year, making up the difference between the two sides of the account, as presented in the foregoing analysis.

There had recently been transferred into the name of the corporation of "The Institution of Civil Engineers" in the bank books £287 15*s.* Consols, and £227 8*s.* Reduced Annuities, being, as it was understood, the final sums payable out of the estate of the first president, Thomas Telford, whose decease occurred in September, 1834.

By the will of the late Mrs. Locke, the Institution was bequeathed the well-known portrait by Sir Francis Grant (president of the Royal Academy) of Mr. Joseph Locke, M.P. (past-president Inst. C.E.), and a sum of £2000, free of legacy duty. The portrait had been received, and was placed in the meeting room; and the amount of the other legacy would be paid by the executors in due course.

The nominal value of the realized property belonging to, and under the charge of, the Institution now consisted of:—I. General Funds, £12,845 6*s.* 8*d.*; II. Building Fund, £4287 14*s.* 7*d.*, and III. Trust Funds, £12,119 15*s.* 11*d.*, making, together with the cash balances of £583 0*s.* 10*d.*, a total of £29,835 18*s.*, as against £26,709 11*s.* 2*d.* at the date of the last report.

In conclusion, the council stated that, in their opinion, and they trusted also in that of the general body, the Institution during the past session had fairly fulfilled its obligations, had been the means of imparting much valuable information, had tended to stimulate the growth of knowledge, and generally to advance the status of the profession.

The thanks of the meeting were unanimously accorded to the president for his zealous efforts in the interests of the Institution; to the vice-presidents and the other members and associates of council for their co-operation with the president, and their constant attendance at the meetings; to Mr. Barlow, for his paper on the Clifton Suspension Bridge; to Mr. Charles Manby, honorary secretary, and to Mr. James Forrest, secretary, for the manner in which they had performed the duties of their offices; as also to the auditors of the accounts, and the scrutineers of the ballot, for their services.

The following gentlemen were elected to fill the several offices on the council for the ensuing year:—Charles Hutton Gregory, president; Joseph Cubitt, Thomas Elliot Harrison, Thomas Hawksley, and Charles Vignoles, vice-presidents; James Abernethy, William Henry Barlow, John Frederic Bateman, Joseph William Bazalgette, Nathaniel Beardmore, Frederick Joseph Bramwell, James Brunlees, George Willoughby Hemans, John Murray, and George Robert Stephenson, members; and John Horatio Lloyd, and Captain Henry Whatley Tyler, associates.

The meeting was then adjourned until Tuesday, January 14th, 1868, when it was announced that the monthly ballot for members would take place, the president would deliver an inaugural address, and, if time permitted, the discussion would be resumed upon the papers on "The Victoria Bridge," by Mr. W. Wilson, and on "New Railways at Battersea, &c.," by Mr. C. D. Fox.

PRESIDENT'S ADDRESS.

JANUARY 14, 1868.—The president delivered an address on taking the chair, for the first time after his election as president.

He remarked, that when the Institution was founded, fifty years ago, on the 2nd of January, 1818, the members were six in number. Two years later, Thomas Telford became the first president; and the Royal Charter of Incorporation was obtained on the 3rd of June, 1828, by which the Institution was firmly established as the recognized representative body of the engineering profession in the United Kingdom. There were now on the register 1472 members of all classes, besides ninety-five students. The present condition and prospects of the profession were briefly alluded to, and it was observed, that the railway system of this country had, by economy of transport alone, been productive of direct saving to the public of 15 per cent. on the capital expended.

A reference to the past records of the Institution had brought to light one document which, Mr. Gregory believed, would be interesting to every engineer. This was a description of the nature and objects of civil engineering, by Thomas Tredgold, Hon. M. Inst. C.E., some of the expressions in which had been embodied in the charter; but as it had never yet been printed in a complete form, the president now gave it unabridged. After defining the duties required of the civil engineer, Mr. Tredgold concluded by saying that "the real extent to which civil engineering may be applied is limited only by the progress of science; its scope and utility will be increased with every discovery in philosophy, and its resources with every invention in mechanical or chemical art, since its bounds are unlimited, and equally so must be the researches of its professors." It could hardly, however, have been foreseen, that the attention of the civil engineer would have been directed to aid in constructions for defence from hostile attack, and even to the improvement of weapons of war. But as, more than two thousand years ago, Archimedes, distinguished first in mathematical science, after carrying out the great work of the embankment of the Nile, devoted the last efforts of his genius to engineering appliances for the defence of Syracuse against Marcellus, so now, less directly and less prominently, but with marked success, the combined labours of modern engineers had been applied to the purposes of national defence, and to this subject the president stated he proposed more particularly to allude.

The application of machinery to the manufacture of rotating fire-arms was first brought under the notice of the Institution, in the year 1851, by Colonel Samuel Colt, of the United States. In 1853 Mr. John Anderson, M. Inst. C.E, the engineer to the Board of Ordnance, suggested the construction and equipment of a government manufactory, in which, by the use of complete machinery, all the processes for the production of small-arms should be carried on successively to completion. This issued, after inquiry before a select committee of the House of Commons, in the establishment of the small-arms factory at Enfield, which was set to work in January, 1857, under the direction of Colonel Manley Dixon, R.A., the present superintendent. Up to December 26, 1867, the total number of new arms made at Enfield was 616,828; while the number converted to breech-loaders on Snider's plan to the same date was 175,550. The long Enfield rifle consisted of fifty-three parts, and passed through about 740 processes of manufacture. The machines used were to a great extent varieties of copying machines, where a standard model was reproduced by a revolving cutter, in wood or metal as might be required. The different pieces, as produced, were checked with templates and gauges, and, finally, the stock, lock, barrel, bands, bayonet, plates, screws, &c., found their way in numbers to an "assembler," who, furnished only with a screw-driver and a chisel, took up the pieces indiscriminately and fitted them together; and so entirely interchangeable were the parts found to be, that a payment of 3·29 pence for each rifle put together, gave the workman wages of about fifty shillings a week. It was stated that the average cost of the long Enfield rifles, made at the Government Factory, including an allowance of 5 per cent. on the cost of buildings and machinery, for depreciation, had been about £2 each, and of the short Enfields complete £2 14*s.* each. The cost of converting to the Snider breech-loader, including £10,000 for the alteration of old machines and the supply of new ones, as well as 5 per cent. for depreciation on buildings and plant, was said to be about 16*s.* 3*d.* per arm. It was stated that, with the present machinery, the Enfield factory was capable of turning out about 130,000 new arms annually. It had been estimated, that the improvement arising from the accurate work produced by good machinery, coupled with better ammunition, had resulted in reducing by 50 per cent. the mean deviation in rifle shooting; while elements of precision and economy had been introduced, by the perfect convertibility of all the parts of small arms, which were previously almost entirely neglected by the English gun-making trade.

Mr. Gregory next referred to the production of heavy armour plates and large guns, with their consequent results. He said that while, prior to the Crimea war, suggestions had been made and partial experiments had been tried with a view to the use of iron for defensive purposes, the credit of the first great trial of a

practical nature was due to the emperor of the French, who built three floating batteries cased with thick iron plates, which were engaged in the attack of the Allies on Kinburn, on 17th October, 1855. From that date public attention was drawn more closely to the protection of ships of war by armour plating, and various experiments were made in this country. It soon, however, became apparent that the subject of the use of iron for this novel purpose was so complicated by considerations of a purely technical character, that it was determined to submit the whole matter to the investigation of a mixed special committee, which was appointed in January, 1861. This committee continued in existence for between three and four years, and their investigations and experiments, which were of great value, formed the best history of the application of engineering science and practice to this particular subject; and it was to be regretted that the four large volumes, containing a full record of all their proceedings, had not been published. The president was, however, enabled to give a brief epitome of the results that had been early arrived at, on points which had previously been uncertain. For example, out of many varieties of material, it was found that the best for resisting shot was wrought iron; that this should be of the softest and toughest quality, any hardness or steelly character being prejudicial; that, *cæteris paribus*, the resisting power, up to a certain limit, varied nearly as the square of the thickness; that corrugations, bosses, or irregularities of surface were disadvantageous, plain surfaces being best; and that the plates should be as large, and with as few joints, as possible. Various constructions of iron defences, both for ships and land fortifications, were examined and tested on a thoroughly practical scale. The experience thus obtained had reference not only to the strength and capability of the material generally to resist shot from given guns, but also as to the modes of fastening, the effect of various kinds of backing, and the general principles which should guide iron defensive construction. But perhaps the most valuable result, in an engineering point of view, was the improvement effected in the production of iron in large masses. When the committee began their labours, the manufacture of armour plates had only been attempted by one or two makers, and even in their hands it was little more than tentative. After three or four years' experience, many makers had come into the field, the general average of quality was much improved and more certain, and plates of 5 inches and 5½ inches in thickness could be produced with their full resisting power. During the last few years the size and thickness of iron plates had greatly increased; and thoroughly sound and uniform plates of large size, 10 inches in thickness, might now be regarded as an accomplished fact. In the middle of 1864 the Iron Plate Committee was dissolved, a step which Mr. Gregory considered to have been injudicious; as the comparative question between guns and iron defences was at that time in a high degree progressive, and, if improvement was to go on, the technical treatment of the subject must still be necessary. Recent circumstances had led to the temporary re-appointment of a government committee to consider the question of the application of iron plates to land forts; and it was to be hoped that their labours might not be prematurely checked, nor until safe data were deduced from actual tests.

Concurrently with the production of iron plates for purposes of protection, had been the increase in the size and destructive power of guns. For many years before the Crimean war, brass and iron guns had been made with very little change of form, although there were in existence compound or built-up guns of an early date. When public opinion was drawn to the application of mechanical improvements to the production of guns of great size and strength, many designs were brought forward, and the large wrought-iron gun of Mr. Horsfall, and the monster mortar of Mr. Mallet, M. Inst. C.E., were cited as examples. But the battle of the guns was chiefly between Sir W. G. Armstrong, C.B., M. Inst. C.E., and Mr. Whitworth, M. Inst. C.E. As far as the construction of the guns was then concerned, the leading points of difference were, that while the Armstrong gun was built up of several rings or tubes of coiled wrought iron shrunk over one another, and over a steel lining, with small grooves to take a soft coated projectile, the Whitworth gun was built of tubes of mild steel, forced with a taper over one another, and over a steel lining, the bore being polygonal, with a mechanically-fitting projectile. The details of both systems were subsequently more or less changed, and in January, 1863, a committee was appointed to make full experiments and to investigate, with two calibres—viz., 12-pounders and 70-pounders—the comparative merits in construction, endurance, range, and accuracy, and in fact, in all the qualities which a gun should possess. The information so collected showed, in both systems, results as to structural strength and efficacy, and accuracy of fire, which had not been previously attained; and while it was not in all respects conclusive as to the comparative merits of the guns, it brought out more prominently than ever the perfection to which artillery might be brought by the application of engineering skill. Irrespective of breech-loading, which had been abandoned for heavy guns in this country, and of rifling, in which the original mode had been to a great extent superseded by larger grooves cut in the chase of the gun to guide soft metal studs fixed on a hard metal projectile, the gun now generally manufactured for the service had undergone considerable structural changes. The most material were, the diminution of the number of parts, and the substitution of outer coils of fibrous Staffordshire iron, for coils of the best Yorkshire iron; tough steel being still maintained for the lining, as best resisting surface wear. The pattern at present in use for all guns consisted of only four pieces: 1, the steel barrel or lining; 2, a coiled tube over the barrel, extending from the muzzle nearly to the trunnions; 3, the breech coil, of three coils in alternate directions, welded together, with a trunnion piece welded on, the whole being shrunk on over the breech of the barrel, and lapping over the front coil; and 4, the cascable. It was considered by the authorities, that guns of this pattern were less liable to injury by accident and less dependent upon perfection in manufacture, and that practically an equal amount of strength was obtained; while it was held that a fibrous iron was to be preferred as more workable, and as giving out its greatest strain over a greater distance than the best Yorkshire iron, which, while stronger, statically considered, did not yield so far before fracture. It was said that this change had diminished the cost of production by 35 or 40 per cent. Prior to the mechanical improvements which had led up to the present rifled guns, the greatest distance to which a projectile was ever thrown from a smooth-bore gun was not much over 6000 yards, and the limit of bombarding range, at high elevations, with the 13-inch mortar, was 4500 yards. With the modern ordnance, projectiles had been thrown with greater precision to a range exceeding 10,000 yards; and the guns of the service made good practice at 6600 yards, indeed better practice than was formerly attainable at 3000 yards. At 1000 yards the rifled gun was eleven times, and at 2000 yards thirteen times more accurate than the smooth-bore. But these improvements would be of little avail in time of need, until smooth-bores were much more largely replaced by rifled guns; as, for all practical purposes, many of our defences, both at home and abroad, were at present almost unarmed.

While such important changes had been effected in ordnance, the advance recently made in naval construction was alike remarkable, and would have been equally impossible without the resources of modern engineering. Without attempting to trace the progress from wooden to iron ships, or all the steps by which naval architects had passed from the earliest to the most recent types of armour-clad ships, Mr. Gregory illustrated the general results by some comparisons between the structures of the *Warrior* and the *Hercules*, as ships of 1860 and of the present period respectively. The arrangement now adopted for the broadside ships of the Royal Navy provided a protected battery amidships, shut in by armour-plated bulkheads, and a belt of armour for the whole length in the neighbourhood of the water line. By these means, in addition to the battery and the whole water line, protection was given to the engines and boilers, and to the rudder-head and steering apparatus. In the *Hercules*, the sides of the ship were recessed before and abaft the central battery, so that by means of embrasures in the armour-plated bulkheads, the foremost and aftermost gun on each side could be traversed on a turn-table, and be fired at an angle of 15° with the line of the keel, while that line was commanded by the guns in the bow and stern batteries. The *Hercules* was 8 inches wider in the beam than the *Warrior*, but 55 feet shorter, and of 883 tons less burthen. She would carry a smaller number of heavier guns, and possessed the elements of greater power, both for offence and defence; but in the former quality she was, perhaps, inferior in some respects to a type of ship now on the stocks. The Royal Navy at the present time comprised thirty-one iron-clad ships, and eight more were building; four of the existing ships are being furnished with turrets, which were to be supplied to two of the new ones. Admitting that this number represented a formidable force, and that in structural qualities the vessels recently built were superior to those of other countries, it must be remembered that many were of doubtful strength, and that the sum devoted to the construction of new iron-clad ships for the current year was less than one-twelfth of the vote for the navy, and was barely sufficient to build three iron-clad frigates—a fact meriting the gravest consideration.

The next point touched upon related to the important bearing of railways in modern warfare. They were acknowledged to have been of great use in the movement and concentration of troops during the war in Lombardy in 1859. In the German war of 1866 the Prussian government organized a special corps, consisting of workmen and railway servants, to act under the direction of engineers and traffic officers, to repair damages effected by a retreating enemy, to work lines occupied by the army, and in case of retreat, to destroy lines in the rear. Mr. Hozier, in his admirable account of the Seven Weeks' War, though conceding the value of improved roads and railways in shortening the duration of campaigns, especially in facilitating the transport of provisions, stores, and a siege train, and in relieving soldiers of heavy loads; yet he considered that the power of railways for the transport of troops had been over-estimated. Mr. Gregory's opinion seemed to be at variance with these views; and reference was made to the number of volunteers transported by railway on special occasions, within a given time, as not being consistent with the conclusions of Mr. Hozier. Again, in the American civil war, railways and steamboats were found to be of inestimable advantage, of which illustrations were given. The railway system of this country was believed to be one of the greatest elements of strength for national defence; and it was mentioned that the confidential reports to the government, by the officers of the Engineer and Railway Volunteer Staff Corps, commanded by Mr. Bidder, past president Inst. C.E., showed that the completeness and the resources of the railway system would enable the whole regular and irregular army to be moved upon any required lines of defence within a few days.

As a *resumé*, Mr. Gregory submitted, that while it was advisable to maintain the efficiency of the government establishments, yet that it would be a mistake to extend them so far as to cripple individual enterprise. In the next place, he referred to the comparatively unprotected state of the Thames, the Mersey, the Clyde, the Tyne, and other rivers leading to rich towns, docks, and shipping: and he suggested the inquiry, whether if forts were thought to be desirable at such places, they might not be of small size, and capable simply of offering resistance to a sudden attack. And in regard to the navy, he thought the time had now arrived when the type of ship best suited for coast defence should be settled. The instinctive feelings of every Englishman called for the establishment and maintenance of a navy sufficiently strong, not only to defend our coasts, but also our colonies and our commerce; and if the government would at once respond to that call, comfort would be brought to thousands at the present time suffering most grievous want.

In conclusion, the president expressed the earnest hope, that the future of the Institution of Civil Engineers might be as useful and as prosperous as its first fifty years had been; and that it would continue to supply men of character and intellect equal to every occasion, and who would join in the defence of their country, by contributing to her moral and material greatness, leaving England's future with confidence to the Great Source of all power and all intelligence.

MONTHLY NOTES.

Ship Canal.—In France the question of constructing a ship canal from St. Nazaire to Nantes has, our readers know, been for many years under consideration. Owing to the numerous shifting and ever-increasing sandbanks with which the Loire is encompassed, none but small vessels find it easy to ascend to or descend from Nantes. The consequence is, that most large vessels enter and leave the port of St. Nazaire, which port is a good one, and has of late years been improved

at great expense by the government. But this transfer of shipping business to St. Nazaire is naturally most unpalatable to the merchants and shipowners of Nantes, and, indeed, to the population generally. They have always, accordingly, insisted on having a ship canal constructed, so as to enable vessels of large tonnage to carry cargoes to Nantes, and receive cargoes there. Some time back the Chamber of Commerce, at their instigation, had surveys of a canal made by a practical engineer, and obtained from the government promise of pecuniary support to the scheme. The chamber has just passed a series of resolutions in favour of the canal. Among other things, it says that it is not only necessary in order to preserve the commercial position of Nantes (the second port in France as regards the number of vessels, and the third in tonnage), but that it would be extremely useful in time of war, by affording a refuge to vessels of war.

The Suez Canal.—It has been suggested by Mr. Campbell, of the firm of Campbell, Johnstone, & Co., that shallow pontoons or "trays," such as are now used for placing ships upon when lifted by the hydraulic presses, or by floating docks, such as that now building for the government for Bermuda, should be made use of for transporting ships across the Isthmus of Suez by the canal; by which means the ultimate object of the canal will be at once attained, and its utility be nearly as great as it may be when the intended depth of 28 feet is obtained by dredging. Ships upon these "trays" could be securely shored up, and they could be cleaned and painted while being taken across. The value of the transit by the canal would be fully proved; and this system of transport for ships, if properly organized, need not be so expensive as to be any hindrance to the free development of the traffic.

The Influence of Chemical Knowledge on Sugar Manufacture.—*The Produce Markets Review* says:—"Of all countries England is the most interested in sugar, not only as the greatest consumer, but as owner of some of the richest producing countries in the world, yet no nation displays greater ignorance or apathy with regard to this subject. Like the Lotos eaters, we are content to listen to the distant waves of progress, confident that the protective system of sugar duties will keep the boundaries of our fool's paradise inviolate. But the old proverb, 'Where ignorance is bliss 'tis folly to be wise,' has certainly no application to commercial matters, for the country that remains in ignorance, whether it be from choice or from indifference, is sure to fall into the rear. In no part of the world is scientific knowledge on mechanical subjects turned to such practical account as in England, and many of our greatest men have made science the handmaid of commerce by applying scientific discoveries to the purposes of every-day life. The telegraph, and more recently the aniline dyes, and Bessemer's iron-working process, are a few instances among many; but sugar, of which the manufacture is completely a chemical process, is entirely overlooked by our *savans:* and yet there is a wide and almost unlimited field for chemical science in perfecting sugar manufacture, which has hardly advanced from its barbarous infancy of crushing mills, windmills, and open pans. The problem of sugar making, which has yet to be solved, is this:—To extract all the saccharine matter as it exists in the cells—that is, in a pure condition, and white in colour—without extracting the injurious salts or acids which coexist side by side with the sugar, and to do this at as small an expense as possible. A problem scarcely less important is the power of detecting by chemical analysis the exact proportion of extractable saccharine matter in any sample of sugar, for it must be observed that the per centage of extractable saccharine matter is a very different thing from the saccharine strength shown by the polarizing saccharometer. We do not hesitate to say, that any chemist who would solve these two problems would render a service to the sugar world of similar importance to that rendered to the world at large by the discovery of the steam engine. While our English chemists are mute upon the subject, the ablest chemists of France and Germany have for the last eighty years been employed in solving the delicate problem of the crystallization of sugar, and the result of their labours, so far, may be seen in the vast continental beet-sugar crops, which are entirely due to the labours of a generation of chemists which has hardly yet passed away."—*Journal of Society of Arts.*

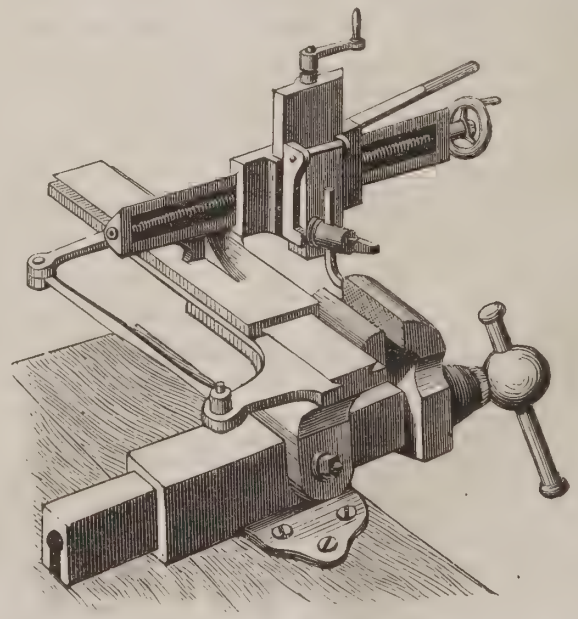
Cotton Growing in Italy.—Professor Giuseppe Balsamo, of Otranto, has just published a paper on certain experiments of artificial fecundation effected by him on the cotton plant. The Neapolitan province of La Terra di Otranto has been a cotton-growing country from time immemorial; but the sorts of cotton grown there are not the best, being the *Gossypium herbaceum*, or the short staple, and the *Gossypium siamense*, which is somewhat better than the former, but far inferior in length, finenesss, suppleness, and gloss to the *Gossypium barbadense*, commonly called the Sea Island or long staple. During the American war Signor Balsamo tried various kinds of transatlantic cotton, and distributed the seeds among the farmers of his province. New Orleans and Louisiana cotton throve well; but Sea Island failed in most instances, for the reason that its pods open in the months of September and October, when the autumnal rains prevail, which spoil the down. Signor Balsamo then thought that perhaps a hybrid of the short and long staple might be obtained which would ripen earlier, and thus avoid the dangerous season. He accordingly set to work, and obtained six hybrids from the *Gossypium siamense*, *Gossypium barbadense*, and *Gossypium rufum*, or nankeen. The latter, being coloured, offered the advantage of showing, by its reddish hue, in what proportion it entered into the composition of the hybrid. The oblique position of the stamina rendered it difficult to cut them off without letting part of the pollen fall upon the pistil; nevertheless, Signor Balsamo succeeded in preventing this, and in bringing the anthers of one species in contact with the pistils of the other. The operation of fecundation was effected about noon, as being the most favourable moment for the emission of the pollen. Various circumstances may contribute to failure, such as rain, which will even prevent natural fecundation; and high winds, which, by carrying off a great part of the pollen, may render this operation wholly or partially abortive. The cotton obtained from those hybrids was of excellent quality, showing a decided improvement of the inferior sorts.—*Journal of Society of Arts.*

Experiments with Lancashire and Cheshire Steam Coal.—The report of Mr. John Knowles, the retiring president of the South Lancashire and Cheshire Coal Association, presented upon the completion of his year of office, contains a large amount of information of great importance. The report embraces a record of the result of the experiments with the steam coals of the district, remarks upon the legislation affecting collieries, and the relation between masters and servants, and a statement of the financial position of the association. As the portion of the report relating to the coal trials requires to be well known, an abstract of it will be read with interest by all classes. The preliminary trials, under the superintendence of Dr. Richardson and Mr. Fletcher, were completed in July last, and show that the steam coal of the district is distinguished by hardness and durability, with the power of resisting the action of the weather; a low smoke-producing power, even when the fires are driven as hard as possible; great evaporative power; the facility with which it can be used to work up the duff or small refuse Welsh coal, invariably arising from exposure to climate; and that it is more completely under the control of the stoker than any other steam coal, and materially lightens the labour of the men. The experiments were conducted in strict accordance with Admiralty rules, and by a government stoker, who had never used Lancashire coal until he commenced to work at these trials. The results in some experiments were as high as 11·77 lbs. of water evaporated per lb. of coal, and in other experiments with a steam jet a total evaporation of 76·65 cubic feet of water per hour was realized; and even the averages show, as compared with the Hartley and hand-picked Welsh coals, a gain in favour of the Lancashire and Cheshire coals of nearly 10 per cent. in power, and of above 25 per cent. in speed, thus:—

	Lbs.	Cub. ft.
Average of all the experiments at Keyham, with Hartley and hand-picked Welsh coals—Lbs. of water evaporated per lb. of coal, from 100° Fahr., ...	9·41	
Ditto, total cubic feet of water evaporated per hour, ...		36·50
Average of the Lancashire and Cheshire steam coals, not hand-picked—Water evaporated, conditions as above, ...	10 10	
Ditto, total cubic feet of water evaporated, ...		46·67
Difference in favour of the South Lancashire and Cheshire coal, . .	0·69	10·17

The experiments have been made indiscriminately with all kinds of Lancashire and Cheshire coals, and under every possible condition. Upwards of 450 experiments, spread over a period of 18 months, have, up to this date, been made. After repeated applications to the Admiralty the commissioners sent down to Wigan in June last Mr. Robert Nicoll, R.N., assistant chief engineer at Keyham; and Mr. W. Lynn, assistant inspector of machinery at Portsmouth, to test the correctness of the results. Their trials, made at the experimental boilers and apparatus erected by the committee at Kirkless, near Wigan, extended over six weeks, and they also tested the coal at sea with the steam-ship *Lindsay*, lent for that purpose by the Wigan Coal and Iron Company, and from the records kept it is fully anticipated that Messrs. Nicoll and Lynn were satisfied with the results; their official report has been ordered to be printed by the House of Commons.

A Miniature Planer.—This tool, the invention of M. Vautrin, of Paris, is designed to be fixed to a common bench vice, as shown in the cut. The jaws of the vice hold the work to be planed, and the necessary reciprocating motion may be given to the cutting tool by means of a lever which is pivoted to a sliding bed, and then connected by means of a joint and arm to an extension of the casting upon which the bed is made to slide. To the sliding bed there is attached a transverse arm upon which the headplate carrying the tool-post and cutting tool is fixed. This head has a



horizontal movement on this arm, and is so moved by means of a screw arranged like that of a slide-rest or hand or feed wheel at one end, and this is turned by the operator, who can employ one hand to give the stroke to the tool, and as each stroke is to be repeated, can move the feed-wheel, and consequently give the tool a side motion, sufficient to take a fresh cut upon the metal held in the vice jaws. The vertical movement given to the cutting tool, is accomplished by means of the handle seen at the top of the plate which carries the tool-post. The freedom given to the cutting tool in the back stroke to prevent its point being destroyed by abrasion is obtained by the plate which carries the tool-post oscillating on pivots at its upper end, the same as in the common iron-worker's planer, as used by the machinist.

Instead of the simple head, as shown in the engraving, the same arrangement as is used in the power planer to enable the tool to be set at any angle and fed by the screw that raises and lowers the cutting tool may be used. The implement, when placed upon the vice as shown, is intended to supersede the use of the file, except for finishing, and at the same time accomplish more and in a better manner than the file and filer is capable of doing. For model and mathematical-instrument makers it is especially valuable, as work can be accomplished by it which would be attended with a great deal of risk if it were clamped in the ordinary planing machine, and perhaps the proportions of the work are so delicate as not to admit of thus holding it. For cutting ornamental rounds and hollows, grooves or corners, it can be employed where no other tool can be brought to bear on the work. It is, in fact, a miniature planer intended for delicate work, and accomplishes on a smaller scale the same kind of work and equally as perfect as its larger prototype. A small size might be adapted for watchmakers and jewellers, while one of larger and stronger proportions can be adapted to the work of the model-maker and the small work of the machinist. At the present cost of files, not excepting its rapidity of reducing surfaces, this miniature machine would be an exceedingly profitable tool on ordinary vice-work.—*American Artizan.*

A New Thames Tunnel.—An important engineering project, which has excited but little public attention, and for which the necessary parliamentary sanction has not yet been obtained, is already in process of execution, namely, the tunnel or subway intended to be driven under the Thames between London Bridge and the Tower. This work is the third mode of communication below London Bridge which has been brought forward by the same company. The first project, for which application was made to Parliament in 1863, was a bridge below the Tower, which was opposed by the Conservators of the Thames. The next was by a subway immediately above the Tower, which was, in its turn, opposed by the Tower authorities, on account of the position of the shaft on the north side of the river, the approach to which would have interfered with the traffic by the Tower stairs. The present project has the sanction of the Tower authorities, and arrangements for the small portion of land on the Surrey side necessary for the approach have been already made. The new tunnel project presents, in some respects, a curious contrast with Brunel's great work at Wapping, which occupied nearly twenty years in its execution. The existing tunnel, now the property of the East London Railway Company, is about 1250 feet between the shafts; the proposed subway will be about 1320 feet; the one cost above £450,000, the other is estimated to cost the comparative trifle of £16,000. Dividend was utterly hopeless in the one case; in the other, with only the same traffic receipts as those of the old tunnel, a dividend of 20 per cent. upon the capital is calculated on. If the estimate be not exceeded it is possible that, with moderate tolls, the traffic receipts will be much greater. Mr. Peter Barlow, F.R.S., who is the engineer of this project, proposes that the descent and ascent to the tunnel shall be by hydraulic lifts similar to those in use in the large new hotels, and that the passengers shall be conveyed from one shaft to the other in light steel omnibuses of perfect workmanship, and driven by man-power upon a system of accumulating force. The friction will, it is expected, be so much reduced by the exactitude of the fittings and the excellence of the materials and workmanship employed, as to make the power of one man amply sufficient for working an omnibus. The bottoms of the shafts will be on the same level, and the subway will dip in the centre to give speed, and to accumulate force for the last half of the journey. Mr. Barlow recommends his scheme as applicable to the relief of the crowded streets.

Utilization of Sewage.—An experiment of some importance is now being carried on at Asnières, near Paris, on a field of about two acres and a half in extent, and situated about 300 yards distance from the mouth of the great *egout collecteur*. Two portable engines are employed daily in pumping 500 cubic metres of sewage water into a receptacle at one end of the field. A part of this water is applied to various crops—vegetable and cereal—and the remainder is treated with chemical agents for its purification. The former application is considered as confirming the opinion that sewage water may be advantageously applied either to crops or to the direct fertilization of the soil itself, without communicating any bad taste to the vegetable products, or in any way vitiating the surrounding atmosphere. Some fine specimens of beet-root, yellow turnips, artichokes, and other vegetables thus irrigated were shown at the late Exhibition on the Champ de Mars. These products were grown at Clichy. The opinion of M. Le Chatelier is, that the cultivated lands around Paris can never absorb a considerable portion of the sewage water; one difficulty arises from the cutting up of the land into small allotments, which increases the cost of distribution; a second from the fact that the principal arable lands lie on high plateaux, whose slopes lie often in directions contrary to that of the streams; and, lastly, the distance from the sea removes the possibility of getting rid of the excess of water in that direction.

As regards the purification of sewage water, M. Le Chatelier considers sulphate of alumina as the most effective agent. He says that by employing in small doses ferruginous sulphate of alumina, obtained by treating *bauxite*, a common mineral found in the south of France, with sulphuric acid, or by washing the ashes of the Picardy alum works, the water of the sewers may be purified almost completely, and in a relatively short time. The quantity of sulphate of alumina required is stated to be between 100 and 200 grammes (one-fifth or two-fifths of a lb.) per cubic metre of the sewage water to be purified. The average amount of impurities per cubic metre in the sewage water of Paris, is found to be as follows:—

	Kilogrammes.
Mineral matter,	1·902
Organic "	0·599
Soda,	0·103
Potash,	0·022
Phosphoric acid,	0·012
Azote,	0·033
Total,	2·671

They contain in solution carbonates of ammonia, lime, and magnesia, as well as small quantities of sulphate of ammonia, and earthy and metallic salts. A precipitate of alumina and aluminate is thrown down, which also incloses light matters in suspension in the water: oxide of iron is likewise precipitated, and, completely neutralizing the sulphuretted hydrogen, assists the deposition. Thus we have at the same time decolorization, clarification, and disinfection.

The experiments which have been made are not, however, deemed conclusive, and a fresh series are now under hand in a smaller reservoir, which has a surface of about 250 square metres, and receives 50 cubic metres of sewage water per hour; the water, after four hours' treatment, is said to pass off through a filtering medium in a very satisfactory condition. There remains, however, the economical question. This process of purification would require basins of many acres in extent, besides the erection of pumps and steam engines, in addition to the still heavier expenditure for the chemical agent employed. The cost of the sulphate of alumina is between one and two centimes per cubic metre of sewage water, so that the quantity required to purify 200,000 cubic metres per day would cost between £80 and £160.

The remaining question is whether the matter precipitated would find a market as manure: but the amount of the chemical agent employed would alone give this precipitate a minimum value of four shillings per cubic metre, while the supply from 200,000 cubic metres of sewage water alone would be no less than 400 cubic metres per diem; and when it is remembered, moreover, that this manure would contain 72 per cent. of inert mineral matter, against 25 per cent. of organic matter and 0·75 per cent. of azote, it seems very doubtful whether a market could be found for such a product.

It is to be hoped that the experiments now being made will assist in bringing about some advantageous application of such precipitated matter.

APPLICATIONS FOR PROVISIONAL PROTECTION FOR INVENTIONS UNDER THE PATENT LAW AMENDMENT ACT.

☞ When the city or town is not mentioned, London is to be understood.

6th December, 1867.

3471 S. Goldstein, Manchester—Wearing apparel
3472 J. W. Kenyon and R A. Armistead—Steam-boilers
3473 J. Durrans, Thurlstone—Covering
3474 C. Kerby, St. Dunstan's Hill—Filtering liquids
3475 W. N. Nicholson, Newark—Spreading grasses
3476 H. J. F. H. Foveaux, Strand—Cell for galvanic batteries
3477 F. Roper, Monson Street—Driving straw elevators
3478 J. Evans, Tewkesbury—Couplings for railway trucks
3479 R. Jones and J. Abrahall, Birmingham—Hollow metallic seamless spheres
3480 R. W. Lindsey, Birmingham—Brass and copper tubes

7th December, 1867.

3481 C. Brazil, Chorley—Sizeing cotton
3482 P. R. Hodge, Adelphi—Heating and forming metals
3483 R. B. Jones, City Road, and W. Powell, Finsbury—Preventing incrustation in steam-boilers
3484 J. B. Morrison, Goodge Street—Operating chairs
3485 O. Barrett and H. Leggott, Bradford—Knife-cleaner
3486 J. Blakey, Liverpool, and H. B. Fox, Oxton—Collars
3487 J. Partington, Astley—Heating buildings
3488 J. Rae, Sydenham, and G. Miller, Glasgow—Railway wheels
3489 W. Clissold, Dudbridge Works—Spinning
3490 J. Beatty, Ballymena—Candle-dipping machine
3491 C. M. Barker, Kennington Park Road—Socket and flange spigot-pipes
3492 R. Warry, Chatham—Fire-arms
3493 A. M. Clark, Chancery Lane—Spinal diseases—A com
3494 J. A. Munn, Commercial Street—Weighing apparatus

9th December, 1867.

3495 E. Keirby, Rochdale—Elastic packings
3496 W. H. Cooke, Oldham—Springs
3497 W. Clapperton, Johnstone—Shaping cask headings
3498 W. Clark, Fortman Square—Clipping horses or other animals
3499 L. Rose, Leith—Preserving vegetable juices
3500 W. R. Lake, Chancery Lane—Excavating machines.—A com.
3501 H. Bessemer, Cannon Street—Fire-bricks
3502 C. Martin, Chancery Lane, W. Barrett and T. S. Webb, Norton—Reduction of titaniferous iron ores

10th December, 1867.

3503 C. Kerby, St. Dunstan's Hill—Filtering liquids
3504 R. G. Lowndes, Auldhousefield and Crofthead—Finishing textile fabrics
3505 C. Conner, Old Ford—Umbrellas and parasols
3506 W. H. Barlow, Westminster—Measuring earthwork
3507 W Palliser, Pall Mall—Ordnance
3508 W. B. Leachman, Leeds—Rotary water
3509 J. Grout and E. Matthews, Hereford—Growing hops
3510 J. W. Burton, Leeds—Treatment of fibrous materials

11th December, 1867.

3511 J. Woolfield, St. Peters—Corrugating sheets of metal
3512 G. Holcroft and W. N. Dack—Steam engines
3513 H. Giles, New North Road—Hats and bonnets
3514 W. J Fraser, Commercial Road—Steam boilers
3515 A. Camme and F. Delpech, Paris—Iron and steel chains without welding
3516 A. M. Clark, Chancery Lane—Presses for stamping or endorsing.—A com.
3517 A. M. Clark, Chancery Lane—Reduction of tin.—A com.
3518 A. T. Carr, Winkleigh—Manure
3519 J. M. Napier, Lambeth—Serving mustard
3520 F. Vita, Paris—Paper pulp
3521 G. H. Nick, Paris—Sheave for ships' blocks
3522 T. A. Weston, Birmingham—Saws.—A com.

12th December, 1867.

3523 G. A. Young, Red Lion Square—Curtain
3524 J. Goodman, Loughborough—Wheels
3525 J. O. Butler, Leeds—Securing tyres of railway engines
3526 J. R. Bailie, Walthamstow—Caissons
3527 J. Ward, Port-Glasgow—Lamps to be used under water
3528 R. Roberts and P. Williams, Pontypridd—Equilibrium slide valve
3529 R. W. Brownhill, Walsall—Water tuyeres for blast furnaces
3530 W. Paxman, jun., Clifton Hampden—Power in cylinders of steam engines
3531 E. Death, Leicester—Steam pumps
3532 W. G. Hanning and G. B. Knott, Newcastle-upon-Tyne, and C. F. Clerc, St. Mary Axe—Lamps.—A com.
3533 J. Collingham and T. E. Smith, Keighley—Spinning and twisting frames
3534 P. Bawden, Notting Hill—Bricks and tiles
3535 E. R. Sintzenich, St. James'—Paper

3536 H. Field, Tulse Hill—Candles
3537 A. V. Newton, Chancery Lane—Cast steel and malleable iron.—A com.
3538 R. Roby, Bury St. Edmunds—Hay-making machines
3539 W. Richards, Birmingham—Fire-arms
3540 J. Robinson, Dalton—Mohair
3541 J. H. Pepper, St. John's Wood, and T. W. Tobin, Old Jewry—Scenic illusions

13th December, 1867.

3542 E. R. Sintzenich, St. James'—Gutta percha.—A com.
3543 G. Whitehead, Newcastle-on-Tyne—Capsules
3544 J. H. Johnson, Lincoln's Inn Fields—Artificial fuel.—A com
3545 G. Marson, Eagley—Retaining the outer end of tapes
3546 J. Williams, Great Saughall—Apparatus for imparting instruction in arithmetic and reading
3547 W. M'Ilwraith and J. Bonner, Glasgow—Looms
3548 L. A. Damm, Seething Lane—Conveying salt water fish through fresh water.—A com.
3549 A. Bullough, Blackburn—Looms
3550 J. G. Settle, Horncastle—Door bolts
3551 T. Pebardy, Hatton Garden—Surgical appendages
3552 W. E. Newton, Chancery Lane—Bench planes.—A com.
3553 L. Christophe and J. Montigny—Tubular grape shot cannon

14th December, 1867.

3554 H. Aitkinson, City Road—Gas furnaces.—A com.
3555 F. Berry, Sowerby Bridge—Metal breaker
3556 A. M'Murdo, Cargenholm—Saving lives in cases of shipwreck
3557 J. Sharples and J. Schofield, Blackburn—Shuttles
3558 W. and F. Bates, Sowerby Bridge—Washing machines
3559 J. Hargreaves, Appleton-within-Widnes—Soda and potassa
3560 R. Tinkler, Penrith—Churns
3561 J. H. Kidd, Bangor Iscoyd—Brattice cloth
3562 G. Clark, Strand—Guns
3563 E. H. Bentall, Heybridge—Controlling the draught of water
3564 T. C. Parson, Bristol—Skates
3565 O. Hollingworth, Newcastle-on-Tyne—Economizing fuel.
3566 A. M. Clark, Chancery Lane—Extraction of ammonia —A com.
3567 E. and A. Tatham, Nottingham—Machines for hosiery
3568 E. Rimmel, Strand—Portable fountain
3569 L. A. W. Lund, St. Martin's—Studs
3570 W. Conisbee, Waterloo Road—Printing machines

16th December, 1867.

3571 J. J. and J. Booth, Rodley—Cutting or dressing stone
3572 J. E. A. Gwynne, Strand—Sinking tubes
3573 W. Huskisson, Gray's Inn Road—Soda and other aerated waters
3574 J. Dawson, Greenock—Treating sugar syrup
3575 J. M. Shackleton, Accrington—Umbrellas
3576 J. D. Kittoe, Clerkenwell—Engines
3577 W. H. Kerr, Clontarf—Porcelain and pottery
3578 W. Jackson and J. Dyer, Birmingham—Valves and valve cocks
3579 M. C. C. Bernieri, Pimlico—Invulnerable cloth armour
3580 J. Stanfield, Betchworth—Hydrogen gas
3581 W. Huskisson, Gray's Inn Road—Bicarbonate of potash and soda

17th December, 1867.

3582 N. Haley and J. Hodgson, Bradford—Twisting
3583 T. V. Mackintosh, Port-Glasgow—Trenches
3584 A. Shrimpton, Redditch—Papering needles
3585 W. Simons and A. Carmichael, Renfrew—Moulding
3586 W. Ross and A. Long, Walworth—Preventing and removing incrustation
3587 E. M. Du Boys, Paris—Liquid meters
3588 S. Marsters, Lynn—Rubbing and washing ropes
3589 F. L. and C. L. Hancock—Propellers
3590 W. A. Gibbee, South Street—Raising water.—A com.
3591 W. E. Newton, Chancery Lane—Tinned leaden pipes

18th December, 1867.

3592 H. Green, Preston—Furnaces
3593 W. Vaile, Newington Causeway—Stereotyping and electrotyping
3594 R. D. Dwyer, Liverpool—Metallic bedsteads and mattresses
3595 J. Patterson, Hull—Capstans
3596 J. Murray, Whitehall Place—Roads or streets
3597 T. Comfield, Chigwell—Breaks
3598 W. Preston and C. Walker, Dewsbury—Condensers
3599 J. Hall, Barrhead—Furnace grates
3600 J. Cockshoot, Manchester—Carriages
3601 H. A. Bonneville, Paris—Rims and hats.—A com.
3602 M. H. Collins, Massachusetts, U.S.—Lamp
3603 O. A. Hébert, New Millman—Musical boxes
3604 H. H. Murdoch, Staple Inn—Propelling canal boats

19th December, 1867.

3605 E. T. Bellhouse, Manchester—Fire-proof floors
3606 G. H. Ellis, Addiscombe—Cleaning boots and shoes
3607 W. A. Hubbard, Ramsgate—Proportional compasses and dividers
3608 J. S. Gisborne, Liverpool—Electric telegraphs
3609 L. M. Becker, Basinghall Street—Electric telegraph and other wires
3610 J. Atkins, Birmingham—Metallic bedsteads
3611 J. Clay, Yardley—Saddles
3612 A. Cochran, Kirktonfield—Finishing woven fabrics
3613 E. Breffit, Castleford—Glass bottle-house pot carriages
3614 W. H. Richardson, Glasgow—Iron and steel
3615 R. Chauncy, Brompton—Emery paper
3616 J. Kerr, King William Street—Breech-loading fire-arms
3617 J. Simmons, Hammersmith—Producing an optical illusion
3618 W. B. Pullar, Bread Street—Fabrics
3619 C. Beck, Cheapside—Joining horn and whalebone
3620 B. Monson, Colchester—Sliding the sash-frames of windows

20th December, 1867.

3621 H. A. Bonneville, Paris—Carding and spinning wool.—A com.
3622 G. Davies, Glasgow—Circular knitting machines
3623 E. Field, Adelphi, and F. P. Warren, Norwood—Chimney tops
3624 L. L. Tower, Massachusetts, U.S.—Measuring liquids

21st December, 1867.

3625 B. Engel, Cheapside—Iron-mould extractor.—A com.
3626 J. T. Kershaw, Islington—Ventilator
3627 J. Kenyon, Blackburn—Boiling size
3628 E. Lord, Todmorden—Sliding surfaces
3629 C. De Bergue and W. Dredge, Strand—Working railway trains
3630 W. Walker, Rochdale, and E. Holt, Newton Heath—Steam pumps
3631 B. Browne, King William Street—Folding bedsteads.—A com.
3632 J. Hadley, Upper Thames Street—Cleaning grain
3633 J. Davidson, Woolwich—Central fire cartridges
3634 W. Hurst, Rochdale, and J. H. Wilson, Todmorden—Flyer
3635 C. G. Wilson, Regent's Park—Pressing cotton
3636 E. and A. Ludlow, Birmingham—Cartridge cases
3637 J. Davison, Bishopwearmouth—Rigging
3638 J. Pick, Falcon Square—Portmanteaus
3639 J. G. Tongue, Chancery Lane—Pomade for the human hair

23rd December, 1867.

3640 J. Rowe, Wrexham—Miners' safety lamps
3641 W. Dixon and W. Brown, Newcastle-on-Tyne—An elastic coupling.
3642 C. W. Lancaster, New Bond Street—Fire-arms
3643 W. W. Urquhart and J. Lindsay, Dundee—Softening jute
3644 R. Crawshaw, Colne—Shuttles
3645 W. Walker, Liverpool—Cotton ties.—A com.
3646 H. F. Bengough, Clifton—Tobacco pipes
3647 C. J. Adams, Stockton-on-Tees—Fire alarm and extinguisher
3648 S. Salter, Stroud—Rotary engines
3649 J. Dawkins, Pembroke—Tanning
3650 W. H. Chase, jun., Brixton Hill—Couplings for driving belts
3651 M. J. Rice, Birmingham—Cutting and heading nails

24th December, 1867.

3652 F. A. Abel, Woolwich, Producing explosive compounds
3653 S. Myers, Kilburn—Roasting coffee
3654 W. Burley and W. H. Glasson, Landport—Plummer blocks
3655 P. F. Tranchat, Paris—Circular cutters
3656 C. Pottinger, Anstruther—Motive-power engines
3657 A. M. Clark, Chancery Lane—Colouring matter
3658 P. Demeure, Paris—Railway carriage break
3659 G. Layton, Liverpool—Soap
3660 F. Render, Manchester—Traps for shooting
3661 T. Harrison, Manchester—Rails for railways
3662 W. E. Newton, Chancery Lane—Alcohol meter.—A com.
3663 J. Addie, Coatbridge, and F. Kohn, Westminster—Blast and cupola furnaces
3664 G. E. Allshorn, Ludgate Hill—Artificial fuel
3665 S. and F. Lennard, Leicester—Warp fabrics
3666 W. Hewitt, Birmingham—Holders
3667 G. J. Hinde, Wolverhampton, and T. C. Hinde, Ynispenllwch—Iron and steel

26th December, 1867.

3668 J. Lightfoot, Burnley—Printing
3669 N. Greenhalgh, Sharples, W. Shaw, Heaton, and J. Mallison, Halliwell—Steaming certain yarns
3670 B. and J. B. Bowen, Chipping Norton—Gloves
3671 E. C. Jetot, E. Hortensius, C. Cros, and M. M. A. d'E. de Jabrun, Paris—Hat protector

27th December, 1867.

3672 E. G. and E. E. Rafer, Paris—Braiding machine
3673 J. Edge, Bolton-le-Moors—Rag rolls
3674 E. J. Hughes, Manchester—Blankets.—A com.
3675 T. J. Ellis, Westminster—Carburetting gas
3676 J. Cockshoot and H. Weatherill, Manchester—Railway breaks
3677 J. M. Rowan, Glasgow—Moulds
3678 D. Steele, Farnworth—Heating liquids
3679 H. Higgins and T. S. Whitworth, Salford—Preparing cotton
3680 J. Clarke, Redditch—Wrappers for needles
3681 A. V. Newton, Chancery Lane—Soles for boots and shoes
3682 J. W. Lewis, Newcastle-upon-Tyne—Warming
3683 A. Dunn and A. Liddell—Metallic casks
3684 C. E. Brooman, Fleet Street—Application of electricity to clocks

28th December, 1867.

3685 J. Goodfellow, Blackburn—Metallic pistons
3686 J. Capper, Birkenhead—Chimney tops
3687 W. Fryer, Birmingham—Self-closing taps
3688 A. V. Newton, Chancery Lane—Making shot and shell for ordnance.—A com.
3689 W. E. Newton, Chancery Lane—Butt hinges.—A com.
3690 W. E. Newton, Chancery Lane—Generating motive power
3691 C. Morfit, New York, U.S.—Cutting soap
3692 R. Howarth, Southampton Buildings—Carriages
3693 L. Hasluck, Tottenham Court Road—A mechanical watchman and reporter
3694 E. Evans, Newington Butts—Sash frames
3695 J. Jowett, Parkhead—Furnaces
3696 C. Churchill, Norwood—Gas burner.—A com.

30th December, 1867.

3697 J. E. Gowen, Portland Place—Raising sunken vessels
3698 R. Fothergill, Aberdare—Producing heat
3699 T. and J. Robertshaw and J. Greenwood, Ovenden—Looms for weaving
3700 W. Kendrick and J. Woolbridge, West Bromwich—Preventing the formation of smoke
3701 G. Glover, Pimlico, Lamps.—A com.
3702 J. Davison, Bishopwearmouth—Furnaces for smelting glass
3703 J. Ascherman, Paris—Cutting hair from skins
3704 A. M. Clarke, Chancery Lane—Permanent way of railways.—A com.
3705 A. Grainger, Lower Kennington Lane—Roads

31st December, 1867.

3706 M. A. F. Mennons, Southampton Buildings—Liquid hydrocarbons.—A com.
3707 M. A. F. Mennons, Southampton Buildings—Vegetable substitute for animal hair—A com.
3708 M. A. F. Mennons, Southampton Buildings—Artificial stone.—A com.
3709 T. Messenger, Dover—Steam engines
3710 G. M'Culloch, Manchester—Thread-polishing machines
3711 W. Barnes, Worcester—Carriage lamps
3712 J. Novikou, Briansk Orel—Spinning hemp
3713 V. L. Daguzan, Paris—Paving
3714 H. Bessemer, Cannon Street—Crude or cast iron
3715 C. G. Hill, Nottingham—Floss silk
3716 W. Wilson, Newcastle—Hats.—Partly a com.
3717 N. Smith, Kingston-upon-Hull—Stoves
3718 A. Allan, Bower Bridge—Brakes
3719 J. H. Johnson, Lincoln's Inn Fields—Spinning cotton.—A com.
3720 A. M. Clark, Chancery Lane—Road sweeping machines.—A com.
3721 R. Tooth, Fenchurch Street—Evaporating liquids
3722 W. and T. Mitchell, Stackstead—Carding engines
3723 J. G. Crompton, Stockport—Felt hats

1st January, 1868.

1 W. R. Lake, Chancery Lane—Regulating the speed of engines.—A com.
2 W. R. Lake, Chancery Lane—Fire and burglar proof safes.—A com.
3 W. R. Lake, Chancery Lane—Electric telegraph apparatus.—A com.
4 G. A. D. Goodyar, Windsor—Propelling boats
5 W. Stroudley, Inverness—Replacing carriages
6 W. and J. W. Wood, Monkill—Cardings and yarns
7 A. M. Clarke, Chancery Lane—Breech-loading ordnance.—A com.
8 H. Milward, Redditch—Needle-cases.—A com.
9 R. W. Morrell and P. Craven, Bradford—Spinning
10 W. J. Fraser, Commercial Road East—Fire places
11 J. Imray, Westminster Bridge Road—Locomotion
12 C. W. May, Paris—Meig's metallic cartridge
13 A. Beard, Gwersyllt—Furnace fire-bars
14 T. B. Daft, Chelsea—Iron ships and vessels
15 J. Ramsbottom, Leeds, and T. M. Pearce, Bradford—Engines
16 B. Vette, Berlin—Articles of apparel
17 D. Foster, Sheffield—Anvils

ON SOME POINTS OF PRACTICE IN IRON FOUNDING.

No. XXV.

PATTERN MAKING—*Continued.*

BESIDES the main condition of safe and facile seasoning and facility in working into patterns, other less obvious but yet highly important qualities are needed in the timber, as has been stated in the paper preceding this. Certain woods, such as oak, for example, possess capillary pores or tubes so large and prominent that, when used as pattern woods, the patterns rammed up in "green sand" suck up the water from the surfaces of sand in contact with them so effectually as to draw closer to their surfaces the particles of sand themselves, and hug these, as it were, around the orifices of suction of the capillary vessels of the wood with a force that prevents the possibility of withdrawing such a pattern cleanly or safely from the sand. It is more than probable that the excellence of deal (fir) as a pattern wood depends to some extent upon the fact that its vessels are not only very fine and small, but that, being a slightly terebintaceous wood, the cut mouths of these vessels are sufficiently smeared with the fine volatile oil and resin together, as to resist the contact of water, and so leave the surfaces of the pattern free of capillarity, and so not indisposed to "draw" with ease and cleanness from the sand. Red cedar owes its good properties quite to the same causes. Several of the very hard woods, such as box or ebony, occasionally though rarely used, have surfaces, when properly handled, almost as smooth, hard, and unabsorbent as a metal. But there are some rather hard woods, and very close in grain, which nevertheless cannot at any time be made to deliver clean from the naked surface of the wood, no matter how well it is handled. Sycamore and poplar and pear tree are amongst these. The reason seems to be that the fibre of these fine and silky woods, unless clean cut across by the sharpest chisel or plane, &c., is always more or less "riffled up" into a microscopically fine fuzz or fringe all over the surface of the pattern, and this holds the water or moisture absorbed from the sand like a coating of sponge, and so hinders delivery. Hence first-rate pattern-makers, when working sycamore, which is far more commonly employed in Great Britain than poplar, take care to finish the surface with keen cutting tools only. The pattern-maker who finishes his pattern of these woods with glass paper, or with the rasp or file, will never produce one which can give a clean good green-sand mould from the naked surface.

The properties in timber to which we have just referred, and some others to which we might extend our remarks, and also the desirableness of making valuable and costly patterns, once they are produced, as durable as possible, all point to the necessity of forming an artificial surface upon timber patterns by means of suitable coatings. These may be either oil paints, varnishes, or various coatings applied by rubbing on or by heat, or both. The first is the most usual method.

The older class of millwrights some thirty or forty years ago usually painted their wheel patterns, or those for engine work or framing, as soon as they were finished, with one thin coat of oil paint consisting of red lead and some powerful drier, such as sugar of lead (acetate of lead), which was let to thoroughly dry in a warm room. The surface was then carefully gone over with sand paper laid over corkwood rubbing blocks, which are indispensable if the arrisses are to be preserved from being all ground off and spoiled; and the pattern, after being rubbed slightly over with powdered chalk, was sent on to the foundry. Later practice and better, has substituted a thin coat of a rather less rapidly hard-setting oil paint, which is usually finished off by rubbing with pumice, employing very fine glass paper where the pumice stone cannot be applied, and then after rubbing over carefully with dry cloths, coating the entire surface over the paint with black lead (plumbago), laid on with hard brushes and grounds of beer (*i.e.*, beer or porter lees), which contain, besides the sugar, starch, extract, water, &c., of the beer, a good deal of isinglass. This sort of black-lead coating may be laid upon the naked wood by rubbing the powdered plumbago directly in with hard brushes; and for small and very delicate patterns, such as for fine ornamental work, that is the best plan to adopt, for it gives the very finest and cleanest impression to the sand. But if more than one or two castings are required from the wood pattern, it should not be so treated, because it rapidly absorbs moisture, warps and distorts for want of any protective, *i.e.*, oily coating. As fine ornamental work which requires to be multiplied largely is usually finally cast from metallic patterns, either of iron or brass, this sort of naked pattern does best for producing the metallic one, but its use cannot prudently be extended much further. Oil paint is, in fact, indispensable as a protection to the glued joints which are inevitable in spur and other wheel patterns, as well as in those for various other objects. These joints should never be made with common glue dissolved in hot water alone. The dissolved glue should be carefully and long stirred up, while kept hot, with about one-fifth of its volume of good thin drying linseed oil. With that admixture it does not "set" as fast as before, and never becomes quite as glassy and hard; but it sets sufficiently hard and well, makes a strong, sound, close joint, and is scarcely affected by water afterwards. In fact, a pattern put together with such oil-glue can only be parted at a joint by exposing it for a considerable time to hot and *wet* steam. But even this glue after a time on naked patterns shows the lines of joints in slightly "tacky" seams, which hold particles of sand, and injure the goodness of the pattern greatly.

We therefore commend the practice to be invariable of painting in oil all permanent patterns, and, indeed, all patterns from which more than one or two castings are to be taken, and without regard to size.

The writer in his own practice has had huge girder patterns of 30 to 40 feet long, and 5 feet deep, painted and even black-leaded over with positive advantage, though intended to be broken up as soon as eight or ten girders had been moulded from them. The moulders work more carefully and easily from a pattern which they see has been carefully made; even in such a plain and coarse case as this "a good delivery" is of great importance, for the bigger the work the more serious is the loss in time and wages produced by "a drop" or a "making up," &c. For such big plain patterns, common light "lead colour" oil paint, made to dry quickly and laid on thin, is all that is needed, and black-leaded over slightly afterwards with mere dry brushes and powder of plumbago, which adheres fast enough to the paint if put on at the proper time.

Though not just in point to our present subject, and already somewhat referred to in a former paper, we may repeat here the importance of strengthening and stiffening all large patterns, such as the above, with wrought or cast iron ribbings screwed on, and so made as to leave impressions easily "stopped out" in the sand. Twisting is fatal to the moulding of a good girder or a piece of framing, and a disgrace to the founder; but very large and thin patterns of deal or even red pine become relatively so flexible by their own weight and size as, unless thus stiffened, to get almost surely out of truth. Besides, these ribbings save the wood of the pattern from destruction in "rapping" and "freeing" in the sand, and so save their own cost by preserving dry pattern wood in an unsplit state to be worked up again into other patterns. For the like reasons *a fortiori*, screw lifting plates should always be provided upon wheel patterns, and the moulders, who are often most recklessly careless of valuable property in patterns, should be absolutely prohibited from "lifting" such patterns by any other means than the screw lifting handles, or from "rapping" the pattern anywhere except upon or through these screws and plates, and, above all, from driving nails or the points of "gaggers" into the wood to lift by.

Some of the most beautiful wheel castings we have ever seen were made at one period for the writer, for crane work, by an old Scottish moulder, who had his own fancy as to the preparation of his wheel-patterns. These he caused to be given two coats of a peculiar oil paint, of the composition of which he made a great secret. It was, however, we believe, made of thin drying oil, spirits of turpentine, and pure white lead, ground up with about an ounce of what is called by the colourman distilled verdigris (crystallized acetate of copper), to the pound of paint. This for the first coat, which when ground or pumiced off, was then given a second very thin coat of the same paint, to which a small quantity of copal varnish had been previously added. He then left the patterns in a very warm corner of the foundry, near the stoves, for a day or two, taking care to observe from time to time that no warping occurred. When thus completed, the surface of the wheel-pattern was of a very light, dry, green-tea colour, and as smooth and polished as a japanned tea-tray; this paint drying intensely hard. Nothing could exceed the beauty of sand-surface, and the freedom of delivery of these patterns in the moulds, nor the exquisite surfaces of teeth, &c., produced in his castings. We remarked, however, that the fine glassy surface, when after a time it began to get *scratched*, more or less, by handling with gritty hands, and by the sweep of the "dry brush" in moulding, ceased to give as good results. In that state their apostle, a venerable sample of an early race of our high-class workmen, now all but

passed away if not quite gone, rubbed them over with powdered French chalk (steatite), and affirmed that thus treated they were as good as at first. We were scarcely prepared to agree in this.

Some moulders also, we have known, who prefer patterns of rather hard wood, such as sound dry mahogany, simply varnished upon the surface with copal varnish until it bears out fully and uniformly. This, we know, was the liking of the late Mr. Francis Humphrys, who informed the writer that it was also the practice of the elder Mr. Clegg, of Liverpool, from whom he derived it.

We ourselves once tried the effect of French varnishing, laid on upon mahogany patterns for engine-work just as in furniture varnishing; but the result was not encouraging. It proved too thin to prevent the absorptivity of the wood, and scratched like the old Scotchman's "Jappon." Upon the whole we believe there is nothing better than any good moderately hard-drying oil-paint, blackleaded over dry.

No well-ordered foundry should be without a good and sufficient stock of seasoned wood for patterns, nor without a properly-constructed kiln or drying-room for desiccating such timber, unless indeed the foundry be situated in or close to some great mart for dry wood, as in London, Manchester, &c., where it can always be purchased, just as and when needed, and cheaper and better than if produced in the works.

In the internal economy of a foundry, nothing is more wasteful and disappointing than the employment of half-seasoned wood, though but too frequent the practice, when the patterns are to be of any permanent value. They warp, contract unequally, split, and change form, and though still capable, perhaps, of being moulded from, one of the results is, that parts intended when cast to go together with a minimum of fitting, are found to require a vast deal more than need be, and sometimes cannot be got together at all, without unseemly thick chipping strips being tacked on to the meeting faces of the junctions in the patterns, or perhaps even that abomination in any good fitted work—packing pieces of iron in the work itself. The stock of fully seasoned pattern wood, in any extensive foundry, should not be left at the mercy of the pattern-makers to cut it up, how and when they like, at their own discretion. Every joiner prefers to work dry wood, which works so kindly in comparison with what is unseasoned. There is, therefore, some temptation always to employ finely-seasoned wood, whether necessary or not, and for all large, coarse, ephemeral patterns it is not so. The best course of management therefore, in our judgment, in a large foundry, is that the foreman of the pattern-shop should be viewed as responsible for the seasoned pattern-woods; should keep a shop stock-book, in which he should enter all seasoned woods delivered into stock and when, and all wood given out; and so amongst other ends see that the stock is kept up. When the drawings come from the drawing-office to him, he should direct the pattern-maker as to the timber to be employed, and check the quantity taken off by each man.

Time is beyond question, for this and every other use, the best seasoner of timber; but space and other considerations usually induce us to abridge the time by artificial seasoning. This for pattern-wood is very commonly done by piling the sawn planks into racks provided over the boilers of the engine which drives the machinery of engineering works. The plan has only one objection, viz., that it is difficult effectually to protect the dry wood from accidental ignition, an accident which we have known occur by sparks flying up from the furnace when the stoker was raking the fire, and lodging amongst the timber. In any large concern we should prefer a desiccating kiln, specially made for the reception of the timber, and heated, if convenience will permit, by the waste heat from some boiler or other fire. The heat applied must not be great, and a steady gentle current of dry air through, is essential. When the wood is quite dry it is best stacked in racks horizontally in the open air, but under cover from rain.

The flat roof of a fire-proof range of workshops affords a very convenient place for such a timber rack, being itself covered in laterally by open louvering and by a roof, both of which may be of zinc on light iron framing.

Patterns of a large size or for purely temporary purposes, which seldom are made from other than ordinarily seasoned wood, are in some foundries "broken up," *i.e.*, taken asunder when done with, and the timber returned to stock. Such timber, though almost always of superior quality, is too often consigned to wasteful and ignoble purposes, such as "barring" boxes, &c., in the foundry. Pattern-makers and joiners have generally a decided dislike to work such once-used timber a second time for pattern or other fine work, and mainly because they do find a little sand and grit, and fear they may find nail points or screws, to dull or spoil their tools.

The course of management we should adopt, is to lay by any such large patterns in some space appropriated to them, in the open air and freely exposed, except to rain, but without taking asunder. After they have stood so, as the wood has all been planed, in a year or two it will be found that the timber is quite seasoned. The patterns then, if done with, should be taken asunder by boys, the wood carefully washed with abundance of water by labourers, and all the serviceable parts stacked with the seasoned new wood, and its employment where suitable should be insisted on by the foreman. Where the surfaces show the paint applied before to the patterns, they may be jack-planed off by boys, ready for the pattern-makers. In many large provincial foundries, more especially those engaged with heavy bridge work or other framing, colliery work, pumping engines, &c., &c., the habit is to store their patterns in thorough disorder, and in the open air; and one may see them going to pieces under sun, wind, and rain, and in all stages towards their naturally rapid end, when so ill-treated, of fire-wood. It is said upon tolerably good authority, too, that in the palmy days of the first or great John Rennie's millwright works at Blackfriars, they made it a practice to burn all their patterns not of permanent use, rather than store them, for which they had not space, or to re-work any part of them, to which the men objected, or to dispose of them and let outsiders get possession of their designs or proportions. The one plan is about as extravagant and absurd as the other. In every well-ordered foundry there should be a fine roomy range of buildings for the storage in orderly arrangement of all the patterns, and with a proper staff of men for their care, cleaning, &c. One part of this on the ground level should be a store for the above sort of pattern timber not intended to be broken up within a short time, which, as we have said, should be piled in the open air. The floors or lofts of the pattern stores should be appropriated to the permanent and valuable patterns, and these should be all classified and laid by, so that by the aid of the printed catalogue any one can be found directly. In foundries where much millwright work or geared work is done, or in marine, land, or locomotive engineering shops, the valuable patterns which belong to these should be all stacked in incombustible stores.

If there be space enough at command, a large shed with an iron and slated roof, one lofty story in height, lighted from the roof, and with a boarded floor laid on joists resting on dwarf walls, with a dry hollow space of 3 or 4 feet in depth beneath, is what we should prefer; and very light tramways may be made with flat bar iron screwed down upon such a floor, for facilitating the ingress and egress of heavy patterns. But when ground space is restricted, brick buildings with some form of incombustible floors, and iron window-sashes, doors, &c., become necessary. The great thing is to prevent the access of fire from without—for probably no building could be constructed that when well filled with dry patterns, and these once fairly ignited, must not be destroyed by the conflagration of its contents. It would be a misnomer hence to speak of a fireproof pattern store.

Wheel patterns when of large size occupy a great deal of room, for they must be stacked *upon the flat* over each other in piles not too high, and only bearing upon each other at the eyes of the wheels. They are, therefore, best placed on the ground floor, which, however, should be boarded; and in a large millwright establishment where spur and bevel wheel patterns of 10 or 15 feet diameter are not uncommon, a light overhead traveller would with advantage be so arranged as to pick out any one pattern from any stack in any part of the room.

The upper floors answer well for all other classes of patterns. The iron and the brass or gun-metal work patterns are usually best classified quite distinctly. But in marine engine and locomotive work, it will probably be always best to make the basis of classification rest upon placing the whole of the patterns for the parts of each engine together, whether they be for iron or for brass. Drawings to full size on boards, templates, gauges, &c., for such work, are best also deposited, not mixed up with, but adjacent and in order with the patterns. This is equally true for "loamboards" or "sweeps" for loamwork, where forming an integral part of one machine or structure.

The pattern store of an old foundry may with advantage be "weeded" about once in seven years, when a vast mass of accumulated patterns will be found, which after due consideration may be broken up, and a large portion of the timber in which will prove only good for fire-wood.

It does not seem necessary to add more as to the economy of patterns

and their storage. A few words may be subjoined, however, as to the arrangement of the pattern-maker's shop. This is very often almost as devoid of machine tools as a cabinet-maker's, and the pattern-makers who require to execute wood turning, &c., are permitted to go into the fitting shops and employ any suitable (or unsuitable) lathe they find vacant. This is miserable mismanagement, however, and bad economy. It leads to gossip and idling, and scatters wood shavings and dust amongst brass and iron, &c. The pattern shop should have a sufficient number of lathes adapted to wood turning, for all ordinary diameters, and one or more large swiftly driven face-plate lathes, for turning wheel patterns or like large diameters. This need not be a heavy or expensive lathe, but should be accurately made, and the hand-rest so formed as to admit of getting at all three sides of any ring-formed solid fixed by the fourth face to the face plate. Wheel patterns are now in a few places considered less indispensable than they once were, by reason of moulding by machinery, such as Jackson's patent, &c.; but wherever the production of wheel patterns is in large demand, as it long must continue in many British and in most colonial foundries, it will be found highly advantageous to combine with this face lathe, a well-made and accurate dividing plate, by the use of which an enormous waste of time on the part of the pattern-maker in "stepping round" with spring dividers the spaces for the teeth of spur or bevel wheels, or those for the "core prints" in mortice wheels, may be avoided.

Wheel pattern-making used to be paid for generally, in the older millwright days, by "piece-work," and we have known a very expert hand able to make at such work, where there was "plenty of fat," *i.e.*, the diameters very large, as much as £7 or £8 per week thus. By the dividing plate any ordinary pattern-maker who can turn in soft wood, can make a wheel pattern by day's work at greatly diminished cost.

Wheel patterns ought always to be *verified* by the foreman, as to circularity, concentricity of eye, form, equality of space, and for pitch of teeth or core prints, before being painted or taken into use. Besides the above tools, the well-ordered pattern-maker's shop should comprise a band saw, a circular saw or two, of about 15 to 18 inches' diameter, mounted upon a good adjusting planed bench of cast iron, and, according to extent, one or more of the wood-working machines known as "general joiners."

In foundries where much framing or bridge work or the like are executed, it would be found of advantage to have a wood-planing machine, the more especially for reducing parallel thicknessed planks to bevelled or feather edge ones. That form is constantly needed to give "strip" or "delivery" in such patterns, and where the pieces are large, the waste of time and wages in reducing by hand with the plane is very great.

It is properly the business of the general foreman of the foundry to fix the quantity of melted iron that will be necessary for each casting of importance as to size. This is usually done either by directly weighing the pattern and calculating the iron required, or by cubing up the volume of the casting and determining its weight in iron. Where the form is regular and simple, the latter is the best and most usual plan. The specific gravity of cast iron varies between about the extreme limits, from 6·800 to 7·600, the latter being white or chilled iron. The mean may be taken at about 7·300, and for ordinary practice the weight of the casting will be had from the formula

$$W^c = \frac{456\, b^c}{1728},$$

where b^c, the volume, is obtained in cubic inches. Where the form is complex, the weight of iron needed is best had from weighing the pattern with accuracy. Then if S be the specific gravity of the material of the pattern, w = the absolute weight of the pattern, as the weights of any two solids whose volumes are equal are as their specific gravities, $w : W^c :: S : 7{\cdot}3$—or such other specific gravity of the cast iron (or other metal, such as bronze, &c., as may be required), and

$$W^c = \frac{7{\cdot}3\, w}{S}.$$

This is the practical reason why it is important to possess the specific gravities of the several pattern woods, &c., as given in the preceding paper. The above give only the nett weight of the casting when clean and free from gaits, &c., but for these an allowance must be made, the amount of which in new or strange cases of magnitude, must be calculated as exactly as may be, but which in general may be sufficiently allowed for by simply multiplying the ascertained weight of the wood pattern, if of hard wood, by from 9 to 10, and if of deal, fir, or other soft wood, by from 11 to 12, as co-efficients which give at once the total weight of casting and a margin for gaits, rising heads, possible box leakage, and waste. It is never wise, however, in large and important castings to trust to this method, without also obtaining the exact weight in iron of the casting itself, and then estimating by judgment and experience whether the surplus margin seems amply sufficient—better often half a ton too much than a pound too little. This margin is known to French iron founders under the name of *assurance*, in Germany, *versicherung*.

In large wood patterns the quantity of *iron* ribbing, straps, lifting plates, &c., forming part of them is often very considerable, and a serious error, though fortunately one in excess, would be committed, if no allowance be made for these in weighing the pattern. The iron work should all be weighed separately before being attached to the pattern, and then when the pattern has been weighed entire, five-sixths of the weight of the attached iron may be deducted from the weight of the pattern, so that if i = the weight of iron in the pattern, p = the gross weight of the pattern,

$$w = p - 0{\cdot}83\, i,$$

for the value of w in the preceding expressions.

Besides wood a few other substances are occasionally employed as materials for patterns, as stated in the preceding paper, of which we subjoin the specific gravities:—

	Specific Gravity.		
Cast iron,	6·8	to	7·6
Yellow brass,	8·3	"	8·5
Bronze or gun metal,	8·4	"	8·6
Zinc,	—	"	6·9
Plumbers' solder (lead and tin),	9·38	"	9·43
Block tin,	—	"	7·3
Type metal,	9·2 ?	"	—
Plaster of Paris (wet),	—	"	1·6
" " (dry),	—	"	1·4
Portland cement,	2·8	"	3·0 ?
Glass (flint),	—	"	3·0
" (crown),	—	"	2·5
Pottery (earthenware),	1 86	"	2·6
Dry loam,	1·3	"	1 5
Papier maché,	0·65	"	0·80
Modellers' wax,	0·95	"	0·98

Dry loam from the "thickness" between "core and cope" in cylinder moulding, is frequently weighed as a check upon the calculated weight of cast-iron cylinders, pipes, and like objects. The safest way is to mould a cube or two of 4 inches on the side with exactness, from the same loam as that employed, and to weigh these to obtain the specific gravity, for loam varies much in density from various obvious causes.

Plaster of Paris, in the shape of the sculptor's "casts," comes frequently as a pattern before the moulder of objects of art. When mixed with the proper volume of water to form plaster casts, plaster of Paris contains about 21 lbs. of water to the cubic foot of plaster, when set but still moist, in which state it weighs from 98 to 101 lbs. per cubic foot. When this is air-dried, or dried in "the stove," it loses from 11 to 12·5 lbs. of interpenetrant water, and the quite dry plaster then weighs from 87 to 90 lbs. per cube foot. It is usually in this state that we have to weigh it against its volume in fluid iron.

Modeller's wax also is in frequent use in the foundries engaged on fine ornamental work, usually as the material in which the artist who models the original work submits his design to the hands of the moulder. Fine perforated work is often thus modelled upon a flat plate of metal or of glass, in Germany. Occasionally objects of sculpture are modelled in wax, and when great delicacy of execution is desired, or the objects are "undercut," or in full relief, the wax is enveloped wholly, except at the gaits and air vents, in loam stuff properly prepared. When the latter is sufficiently dried and desiccated, the temperature of the stove is raised to a sufficient point to melt out the whole of the wax, leaving the mould hollow; and after a prolonged "stoving," the loam is made so completely to absorb the wax as to prevent the latter from volatilizing and blowing, when the hot metal fills the mould. Another method is to coat the wax mould over with a sort of resist paste of glue and sugar or molasses, thinly laid on, which prevents the loam absorbing any wax when the latter is being melted out. In either case a most liberal use of the vent wire all over the surface is necessary, in order to prevent blowing in pouring.

This method is less in use than formerly, and only for small objects; all large pieces of statuary are moulded by built up blocks of loam, with

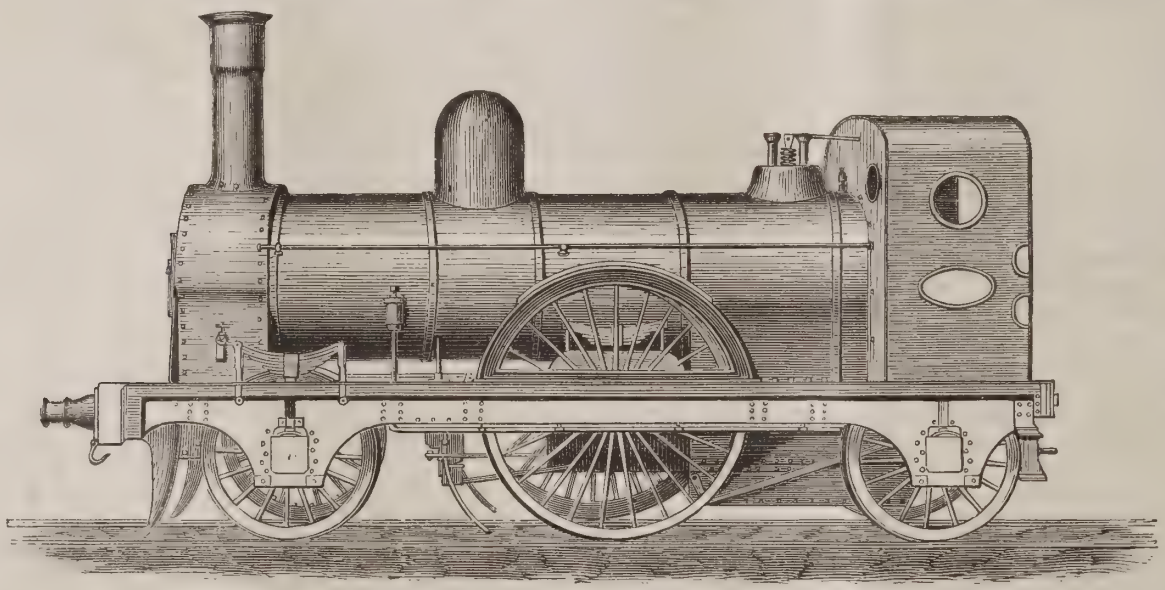
properly arranged partings, so that the clay or plaster of the model can be extracted in the usual way.

All metallic patterns are much improved in their "delivery" by being finely "blackleaded." Prior to the application of the plumbago, the surface of brass or gun metal patterns should be "roughened," by leaving them wetted with a solution of sal ammoniac. Zinc, solder, or type metal or other such soft alloys, will "take" the blacklead at once, if the surface be clean, especially from grease. Papier maché, plaster of Paris, &c., should always be blackleaded, over thin, hard, oil paint. Cast-iron patterns should be rusted, as in preparing to "brown" a gun barrel, by any solution which increases the tendency of the metal to oxidize. Sal ammoniac, dilute hydrochloric acid, common salt in water, all answer the purpose. The rust requires to be completely got off by the "scratch brush" of wire, before the blacklead is applied.

This seems pretty nearly to embrace all we need say as to models or patterns, the materials and methods of their production, their use or employment, and the economy of their preservation or storage.—Ed.

THE LILLESHALL COMPANY'S EXPRESS LOCOMOTIVE AT THE PARIS EXHIBITION.

Amongst the many locomotives at the Exhibition, some of which we have before noticed, is one manufactured by the Lilleshall Company, which, being a first-class example of an express engine, is worthy of a special notice. The engraving shows a perspective side view of the engine. It is of the inside cylinder type, and with one pair of driving wheels, the size of which is given in the following list of dimensions of the principal parts of this engine. The framing is formed of two pairs of strong deep plates, which extend the whole length from the piston back to the leading buffer beam; they are further strengthened by cross-stays. The trusses for carrying the central bearing of the crank shaft are cut of a solid slab. The boiler is of large size, and constructed to burn coal. The crank axle is of steel, as well as are those which carry the trailing and leading wheels. In the fire-box a brick arch and deflecting plate are placed for facilitating the burning of coal. In the driving wheels the counterweights are forged in one piece with the spokes. The engine is fitted with Ramsbottom's duplex safety-valves, injectors, and self-lubricating apparatus; while the valve gear is fitted with Allan's straight link, by the introduction of which a nearly constant lead for all the grades of expansion is obtained, as well as an equal opening for the ports on both the front and back strokes. The weight of the engine loaded, in working trim, is 31 tons 10 cwts.; and empty, 27 tons 11 cwts.; the working weight being distributed thus—on leading wheels, 10·5 tons; on driving wheels, 12·69 tons; on trailing wheels, 8·4 tons. The dimensions are as follows:—



Cylinders, 16 inches diameter; 21-inch stroke.
Driving wheels, 7 feet diameter.
Trailing wheels, 4 feet 3 inches.
Leading wheels, 4 feet 3 inches.
Length of wheel-base, 16 feet 6 inches.
Boiler, 4 feet 3 inches outside diameter. It contains 186 $1\frac{7}{8}$-inch tubes, 11 feet 2 inches long, spaced $\frac{3}{8}$ apart; the tubes being placed in vertical rows, as is now usual in locomotive boilers.
Area of external tube surface, 1009 feet.
Area of grate, 18·5 square feet.
Total heating surface, 1121·25 square feet.
Blast orifice, $4\frac{3}{8}$ diameter.
Pressure of steam in boiler, 120 lbs. per square inch. V. D.

ANOTHER NEW STEEL.

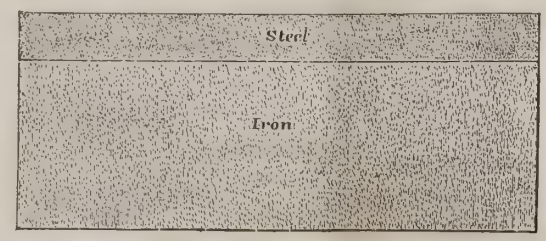
Of late we have heard of several new processes for producing steel, but of the practical value of any of them extremely little information is known; and without being able, as yet, to say exactly in what the process of manufacture consists, we are able to speak of the high character of a certain alloy which has been produced in Glasgow by Mr. J. P. Smith, C.E., the secretary to the Institution of Engineers in Scotland. This alloy has now been used for a variety of purposes, producing bells of various sizes, of extremely clear and perfect tone; but it has, moreover, shown unheard of durability as a metal for cutting tools, more especially when used for turning and planing metals. It has been tried in several works—Messrs. Napier, of Govan, the Anderston Foundry Co., and elsewhere—in Glasgow, where cast iron was cut with it at the rate of 60 feet per minute. This, however, was an early result; and during the last month it has been tested against the best tool steel. In the experiments the rate of cutting was commenced, we believe, at 50, whence it was increased to 75, and then to 100 feet per minute; and a few days since Mr. Smith informed us that he had just heard from the Darlington Engine Co., that 200 feet per minute on Bessemer steel had been reached, with the edge of the tool remaining quite sharp and unworn. A Bessemer steel piston rod had been turned from end to end at this rate, whereas when an ordinary tool was used a few turns of the lathe rubbed the cutting edge so blunt as to require re-grinding. Mr. Smith's patents are not yet complete; we of course cannot do otherwise than approve of his reticence, as it would be most unwise for him, until his specification is filed, to disclose his method of production.

We do know, however, that it consists in adding certain substances to molten cast iron; these are added, we believe, but a few moments prior to the metal being cast, and their addition has the effect of eliminating the silicon in large yellow lumps, some of which we have seen—the silicon being probably eliminated in the state of silicic acid ($Si\,O^3$), whilst the carbon is separated in the state of extremely thin, but often large graphitic plates.

The metal is strictly a cast metal—that is to say, it cannot be forged; and indeed the first samples were, we believe, extremely brittle: this defect, however, Mr. Smith has now overcome, and he uses it in the form of short bars, which are held in special and ingeniously constructed tool-holders, which are again fixed in the slide-rest in the ordinary manner. The retaining power of the holder consists in the grip

produced by two wedge surfaces abutting against each other, not in alternate directions, but the incline of both the tool and that of the wedge being both in the same direction, that is, downwards; so that by this adaptation the tool can at once be set up to any height, without the least chance of the pressure of the cut forcing it downwards—the pressure of the cut, indeed, tightens the tool by forcing the two wedge surfaces firmer together in the socket of the holder. The material is capable of receiving the most delicate degrees of temper, and when it is required to be very hard is cast in chills of suitable shape. The specimens we have examined exhibit the most perfect homogeneity, and in some of the fractures the crystals are so small as to be scarcely visible under an ordinary pocket microscope.

Another peculiar and very valuable discovery which Mr. Smith's experiments have developed, is the production of a bar of metal of various qualities; that is to say, Mr. Smith has shown how to produce a bar of metal which shall be common cast iron for any part of its thickness, and coated all over, or at one or more sides, with any required thickness of steel. For instance, if we take the case of a locomotive engine motion bar, it can be made with as thick or as thin a coating of steel on the wearing side as desired, and yet perfectly united and thoroughly in one piece with the cast iron below, as in the diagram.



Mr. Smith has also cast projectiles with a very hard steel punching front and a soft rear, his object being to produce shot that will not easily break when fired against armour plates or stone forts, but which, on account of the great hardness of their striking ends, will possess great punching endurance. It is extremely curious and interesting to examine the fractures of such compound castings; the junction of the two metals does not take place gradually, as we might expect, but a perfectly straight, even, and true line marks the boundary of the two conditions of the metal. The processes we have alluded to are only in the early stages of their development, but their value cannot be questioned, and certainly they mark another era in the vast strides of metallurgic science and practice which are now taking place. We are most truly living in a day when iron metallurgy is in a most metamorphic state.

Mr. Smith's tool steel is, we understand, in the market, but in limited quantities only as yet, and we hear that it is getting into demand.—V. D.

COIN AND COINING.

By Joseph Newton, Royal Mint.

(*Continued from page* 334.)

The coins which accumulate rapidly in the catch-pans of the presses are removed by the attendants, and carried in trays to tables close at hand. There they are carefully examined, and those which are in any way imperfect are rejected, and condemned to be remelted and recast into bars. As from the printing press there sometimes result spoilt sheets, so from the stamping machine defective coins occasionally emanate. Nothing, indeed, that is mechanical in its movements is *quite* perfect in its action, and skilled supervision is always needed to correct inevitable aberrations. The proportion of badly-struck coins, known in mint *parlance* as "brockages," is, however, as a rule very small—not more than the fourth of one per cent., and these are due mainly to imperfect adjustments of the presses, or the breaking of dies. The coins which successfully stand the test of scrutiny at the examining tables are deposited in canvas bags preparatory to the balancing up of good, bad, and indifferent work, which takes place in the Coining Press Room at the close of every day. The good coins, after being weighed in copper skiffs, and apportioned once more into the respective quantities known as "journeys" of gold, or silver,* are ticketed and sent forward to the Automatic Balance Room. The arrangements of this department bear testimony of a very striking kind to the improvements made of late years in mechanical science. It contains seventeen small machines, which for excellence of design, and beauty of minute constructive detail, certainly equal, if they do not excel, any mechanical apparatus in existence. They appear, indeed, when in motion, to be almost endowed with intelligence, and they really exercise judicial functions. Their duty is to receive each and every individual coin from the presses, and to answer the question as to whether or not it is of the legal weight which entitles it to pass into circulation. This duty the automatic balances actually perform with a speed, regularity, and exactitude, impossible of accomplishment by any direct human agency. No matter what extent of skill, care, and aptitude the manipulator might bring into play, he could not weigh coins to that extreme nicety which the Mint machines accomplish. Through their interposition the beautiful natural law of gravitation is enlisted into the service of her Majesty's money-makers, and the results attained are almost as infallible as is the action of the law itself!

Of the importance to the Mint, and to the community at large, of the accurate weighing, or *Sizing*, as the ancient term was—of all pieces of gold and silver issued from the royal establishment, it may not be improper at this point to say something. From the earliest period in the annals of Minting, its consequence and its value have been recognized by those initiated in the art. Even before coins were in use at all in Great Britain, and when only slips, or dumps, of the precious metal represented money, these latter had to be *sized*. It was necessary that they should vary in weight, in order to facilitate traffic, just as we now possess coins of divers denominations for the same purpose. Unjust balances, which the highest authority tells us are "an abomination," were, however, in use in those primitive days, as they are in these more refined times, and it became essential that the authority of the law should check the evil. Then appeared upon the rude dumps of metal, stamps indicative of their weight and guarantees of their genuineness. The artistic decoration of coins followed, and the Roman occupiers of British territory pushed this forward to a high state of advancement.

Without pursuing our researches further into the misty atmosphere of the remote past, let it be at once stated that all the Acts of Parliament, and all royal proclamations in this kingdom, having reference to the Coinage of the Realm, define with more or less precision what should be the standard weight and the standard degree of fineness of each denomination of coin. Those acts and proclamations, nevertheless, admit that complete uniformity of weight is unattainable. A certain variation above and below the true standard weights of individual coins is legally permitted. This deviation is known to this day in the Mint as the "remedy." It will be readily understood that the varying density of the metals used in the manufacture of money, is one substantial reason why exact uniformity of weight cannot be obtained. Rolling and drawing the material, as has been described, may and does accomplish much, and careful punching may do more. Thousands of planchets measured by a Whitworth gauge, might exhibit no difference in size. Let them be placed singly in a Mint balance, and variations in weight will manifest themselves very perceptibly. In regard to the standard degree of fineness, a similar difficulty presents itself. Standard gold should contain precisely twenty-two parts of fine gold and two parts of alloy (copper). The most skilful refiner in the world cannot, however, so disseminate the two metals throughout a mass as to insure that each one of a thousand sovereigns produced from it shall contain exactly its proper proportion of gold and copper.

Mechanically and chemically, therefore, there are difficulties in the way of money making, and legal allowance is very properly made for both. These allowances, owing to the excessive care exercised in all

* A journey weight of gold is equal to 15 lbs. troy, and a journey weight of silver to 60 lbs. troy; bronze coin is apportioned in half cwts. avoirdupois.

its departments, are smaller in the Royal Mint of Great Britain than in any other mint in Europe.

We shall deal at present with the mechanical peculiarities associated with the sizing and adjustment of coins, reserving the mode of assaying their rate of purity to future opportunity.

The legal "remedy" upon gold coins is, as may be imagined, very small, in fact, 12 grains troy upon every 1 lb. weight, comprising in number 46 and a fraction. That is to say, that no single 1 lb. weight of sovereigns issued from the Mint must differ in intrinsic value from another 1 lb. weight more than two shillings; and in order to insure this, no two individual sovereigns must differ in weight more than a quarter of a grain, or in intrinsic value more than one halfpenny on either side the theoretical standard.

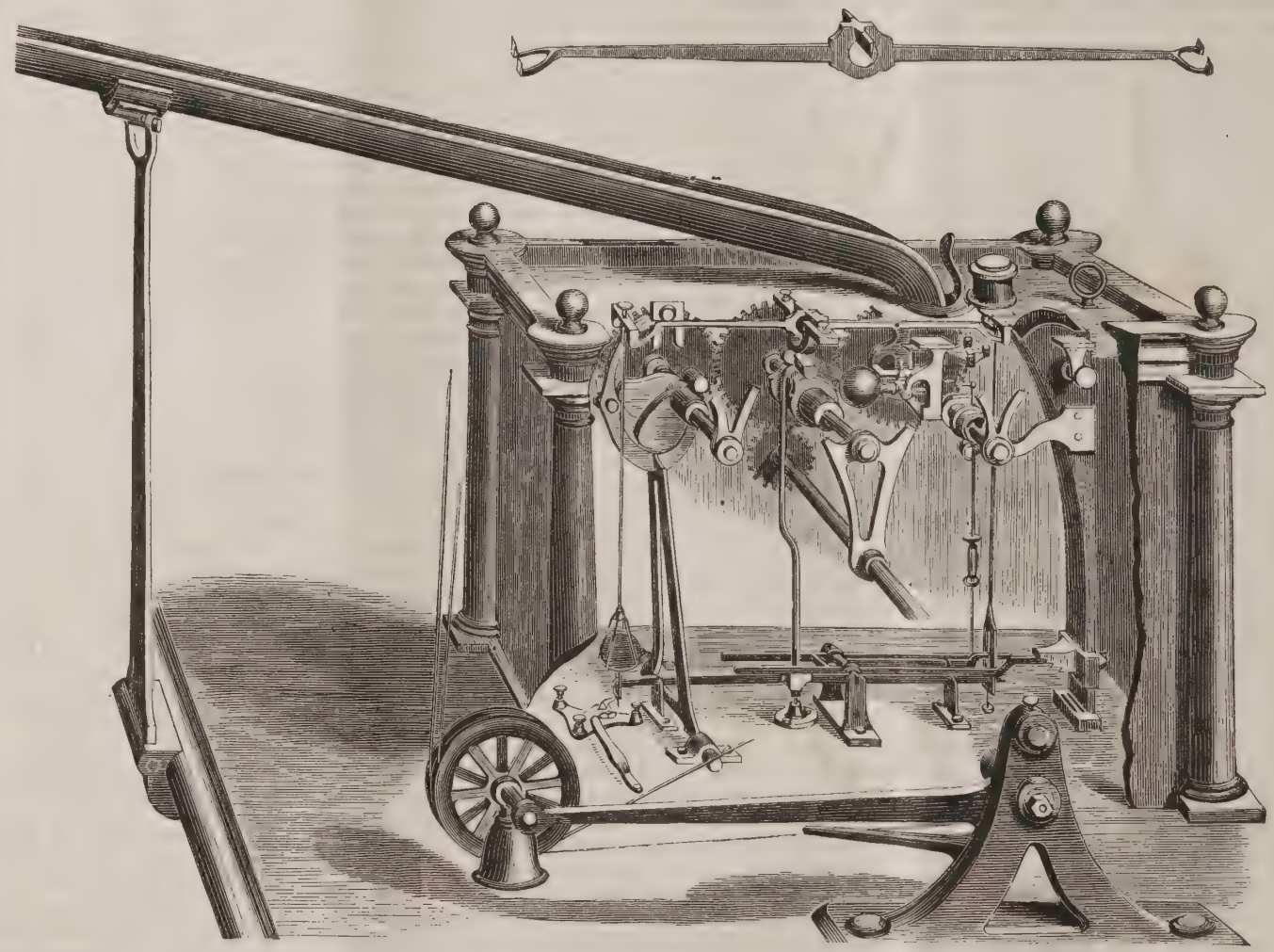
Silver and bronze coins are merely tokens of value, and individual differences of weight are allowable to a greater extent than in the case of gold. The Mint remedy consequently is larger, but by careful working of the metals they are generally brought to a state of accuracy closely rivalling that obtained in the production of gold coins. Invariably a 1 lb. weight of silver coin, when newly minted, and of whatever denomination, would be found to represent the sum of £3 6*s*., whilst a pound weight of bronze pieces would represent 4*s*. Individual differences there might be found in their weights, but collectively those would be balanced.

The sovereign and the half-sovereign should be, both nominally and intrinsically, of the respective value which their names imply. It has been explained that they cannot be made so, quite, and the following table will show at a glance in how far they may differ:—

TABLE OF WEIGHTS AND DIMENSIONS OF GOLD COINS.

Denomination of Coin.	Standard Weight.	Legal Maximum Weight.	Legal Minimum Weight.	Legal Remedy.	Diameter of Coin.
	grs. pts.	grs. pts.	grs. pts	grs. pts.	inches.
Sovereign, ...	123·274	123·531	123·017	0·256	0·875
Half-sovereign, . . .	61·637	61·765	61·508	0·128	0·735

These weights and dimensions are the guides for her Majesty's coiners, and it is not too much to say that no gold coin which is out of remedy can escape the Mint walls. The automaton balances are an effectual check as regards weight, and if the weight be right the dimensions cannot be wrong. Supposing that some coins issued may



be just upon the verge of the limit, on the *light* side of the standard, and have barely escaped rejection on that account, then it might be argued that these would speedily become actually light by abrasion. So no doubt they would, but when in circulation another law affects them. They may legally remain in existence as current money until friction and wear and tear have reduced each one in weight to grains 122·500 pts. At this point, or rather at any point below this, the Bank of England is justified in cutting short their individual careers; about half a grain is therefore the smallest margin which a sovereign can possibly have to spare for enabling it to fight the battle of life, whilst if issued at the maximum Mint weight it may have a grain, or slightly more.

Having endeavoured to explain the origin, and to demonstrate the importance, of weighing operations in the art of coining, it may be stated that prior to the year 1851 the whole of the gold and silver planchets produced at the Royal Mint were weighed by workmen known as "sizers." These occupied a large room, and were each supplied with a tiny pair of scales. They were supposed to detect those pieces which were "out of remedy," either on the "too heavy" or "too light" side of the standard. The too heavy pieces were thrown on one side, to be reduced by filing, and those which were too light, on the other, for relegation to the Melting House. The medium pieces were passed into an "accepted" receiver. Constant practice, no doubt, induced to a limited amount of exactitude among the sizers,

but in time eyes and fingers grow weary, and it is pretty certain that under the old *régime* many very heavy and many very light coins were issued from the Mint.

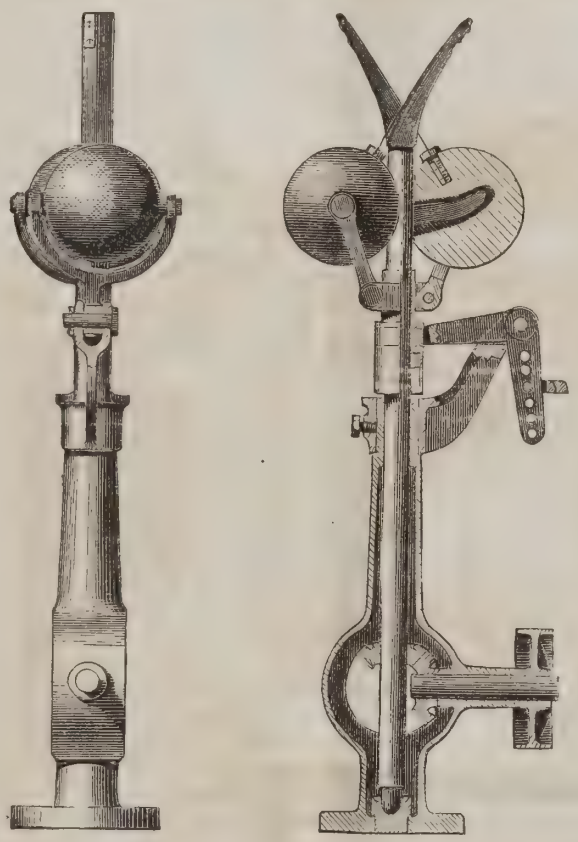
In the year named all this was changed, and Captain Harness, R.E. (now Colonel, C.B.), was the introducer of the system of automatic weighing, which has proved of inestimable value to the Mint. By this self-acting arrangement all the pieces weigh themselves singly, and separate themselves into the three categories named light, heavy, and medium. Of course, for the accomplishment of this effect a beam is required in each machine, and in the automatic apparatus it is made of steel and delicately poised on knife-edges, resting on loops of the same metal. To render more easy of comprehension the description of the contrivance which is to follow, an illustration of the Automatic Balance with several of the details enlarged is annexed.

(*To be continued.*)

STEAM-ENGINE AND OTHER GOVERNORS.

DAVEY & DAVY'S ISOCHRONAL GOVERNOR.

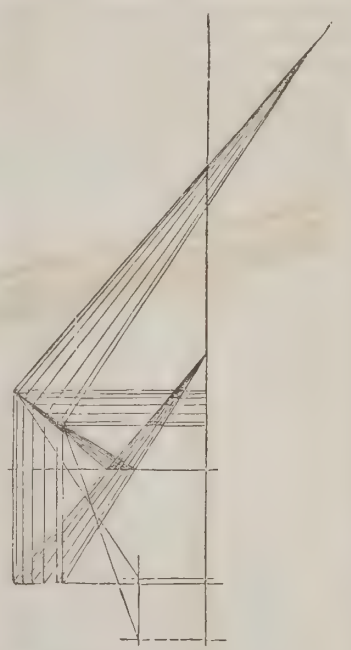
MANY attempts have from time to time been made to obtain perfect synchronism with the ball governor of Watt, failing more or less because of too great friction, and from excessive complication. In the so-called



isochronal governor, which we illustrate above, these two evils are obviated; the friction is reduced to an unimportant item, and in point of construction the governor is exceedingly simple. It is of the class termed "parabolic;" that is to say, the balls move in a parabola, from which it follows that they rest indifferently in any point on the path in which they move for a given constant speed. Any variation in velocity causes the balls to move in either direction, as the case may be, until the proper speed is again restored.

Bearing in mind that the vertical height depends on the speed, it is evident that if the height be constant so will the speed be also, and if the governor and its appendages could be made entirely frictionless, then the variation in speed would be reduced to an amount less than any assignable one, though still of finite value; for the balls possessing weight, possess also inertia.

It will be seen from the engravings that the balls are moderately small, the vertical height small, and that the ordinary pendulum legs are dispensed with, and in their place are substituted very light straps of thin flat steel, not submitted to rubbing friction at all, but suspended from, and forming a tangent to, curved horns forged on the spindle. The curve of the horns is of such a form that tangents to it are all normals to a parabola; the centre of gravity of the balls, therefore, moves in that curve, as the suspending straps successively assume different tangents to the horns. The principle of construction will be readily understood from an inspection of the diagram. Different points in the parabola are first found, and from these points are drawn lines perpendicular to the axis of rotation; from each of the lines last named are set off on the axis the vertical heights successively, commencing with the lowest. Then are drawn lines from each point in the parabola through the corresponding points set off on the axis; the intersection of the lines—each with the next in succession—on the other side of the axis, then determines the curve for each horn. With an ordinary governor a leg so short could not well be used, seeing that a small movement of the balls would considerably decrease the vertical height; but in this case it matters not how short the legs are, the constancy of the speed being in no way affected by it. The amount of increase or decrease in speed necessary to overcome the friction and inertia, is the maximum inequality to which the engine is liable if governed by means of this governor, and in practice it is found to be sufficiently small to be neglected. A small air cylinder is placed on the spindle to check the momentum of the balls when started suddenly by means of a sudden change of load on the engine, and which prevents the throttle valve from being opened or closed too much.

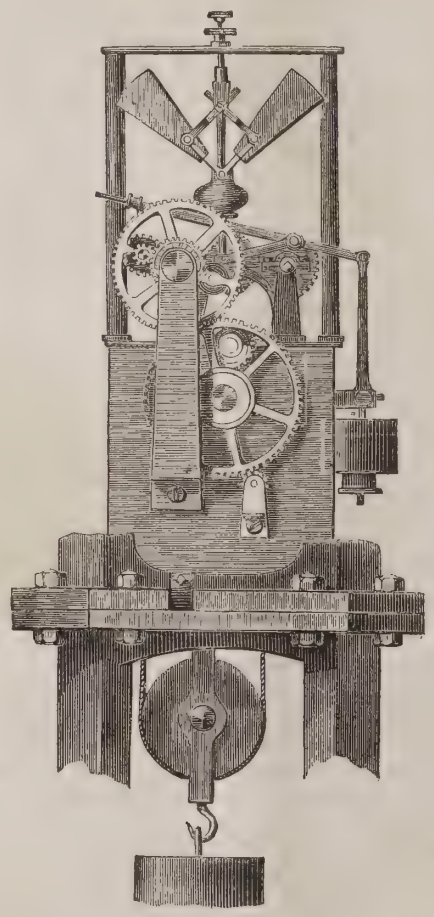


The preceding description of this modification of the Watt governor is that of the inventors and patentees, and, it must be admitted, is fairly and modestly enunciated. Strictly, however, this governor, which certainly possesses some advantages as well as those of cheapness and smallness of friction, cannot be called isochronous. The only governor that properly warrants that title is one which by principle is of such a nature that its parts can only remain in equilibrium while rotating at one constant velocity. Mr. Charles Siemens' governors were of this character, and were justly termed by him chronometric; because each governor was in fact a clock, adjusted to go at a certain rate, and limited to that by a revolving pendulum, in place of the oscillating pendulum and escapement which makes a common house clock a governor to itself. Mr. Siemens' later governor, as described in the "Philosophical Transactions," and a few months since fully in this journal, involves like principles.

The governor, however, above described, is of the class of Watt governor still, though improved, and is subject to the disadvantages (though in a mitigated form) that always remain to Watt's centrifugal governor. In the latter, the angle of separation of the suspending legs of the balls increases, as is well known, with the velocity of rotation. It is zero when the velocity $= 0$, and 180° when that is infinite; the sensibility varies with this angle, and diminishes rapidly as the velocity increases. Hence the Watt governor is not an absolute regulator, adjustable for one fixed velocity—nor although the same governor may be employed within wide limits of rotative velocity, yet it is properly no more than a *uniformatizer* of velocity, and its proper function is no more than to delay sudden changes in velocity. Many valuable improvements have of late years been made upon the Watt governor, leaving it in principle untouched, and Messrs. Davey & Davy's is one of these. Many of these improvements have been described by us from time to time, as, for example, Mr. Porter's Watt governor, in which extreme sensibility attained (as we can personally testify) by his substitution of high velocity with small weight (or inertia) in place of low

velocity and great mass, as was Watt's practice, to obtain the necessary energy in the balls, and in the introduction of the vertically dropping centre weight, with the gravitation of which the rotatory balls are always in equilibrium. For this weight of course a spiral or other spring upon the centre spindle might be, and has been, substituted. We cannot but think that Messrs. Davey & Davy's governor would be still further improved by the application of such a spring, and by lightening the balls and giving them a higher velocity.

The limit, however, to delicacy with a Watt governor depends upon the limit of velocity with which a heavy body begins to fall in air. An extremely simple and important modification of centrifugal governor, which is independent of this limit, was shown at the Paris Exhibition, the invention of Mr. Pickering, an engineer of New York. In this, upon the mid length of two springs, straight or curved, and symmetrically arranged in the same plane and at opposite sides of the axis, or spindle of rotation, are placed two equal balls. As these fly out by increased velocity of rotation they bend these springs; as they get nearer the axis by reduced velocity, they permit the springs to relax, and the flexures act upon the throttle valve, &c. Here the velocity of movement of the balls is only limited by their inertia, and by the velocity with which a tempered steel spring alters its form, which, if the spring had no inertia, is, in fact, that at which an impulse is transmitted through tempered steel, or many thousand feet per second. With light balls and fast rotation a governor of this sort ought to be found perhaps as sensitive and as rapid in its action as any practical purpose in connection with steam-engines could require.



There are other uses, however, for which governors are required, in which this is not sufficient; an absolute regulator, in principle like the chronometric governors of Siemens, or the pendulum and escapement of the common clock, becomes indispensable. Such are the governors, for example, demanded for the regulation of the clockwork movements of great equatorial telescopes, now so numerous. For these the escapement and transverse pendulum won't do, because the movement of all such combinations, though uniform over a large unit of time, is for small intervals intermittent and unequal. At Greenwich, therefore, the Siemens' chronometric governor has, with some modifications, been adapted to the great equatorial. To others, several governors, various in details, have been applied, and to some the old idea of Watt, of a constant stream of water flowing from a vessel maintained at a constant head. One of the most perfect of isochronic governors was contrived by Mons. Foucault for equatorial use, and was first described in the "Comptes Rendus," t. lvii., for 2nd November, 1863. It has been applied to the great achromatic telescope constructed at the expense of the city of Marseilles, and now in use there, of 0·80 metres aperture. It has also been applied to a fine instrument constructed for the observatory at Lima, the governor for which was made by M. Eichens (formerly Secretan & Eichens), of Paris, who manufactures these instruments for steam-engines and other uses.

In the Foucault governor the construction is such that the period of rotation is independent of the angle of obliquity of the two heavy vanes which perform the functions of the ordinary balls. To the ordinary governor, modified as above, M. Foucault added a system of levers, which are so connected either with a central mass free to rise and fall, or with a central spiral spring, that they tend to lift the weight or compress the spring with a force increasing as the resistance, and as the vertical range of lift or of compression. The vertical resultant of the different forces, weight and centrifugal force, which act on the several movable pieces of the governor, varies in the same manner. It is therefore possible to equilibrate these for a given velocity of rotation. That being done, the action is obvious, and it is easily seen that the resistance furnished by the vanes of the governor will be alternately zero, or the greatest possible, and that there can be but one velocity at which it is in equilibrium with any excess of force or velocity in the motor. The unstable equilibrium of the system, therefore, makes it an absolute regulator.

The fig. will convey a general notion of the construction of this governor, for the detailed description of which, however, a number of illustrations to a large scale would be requisite. The governor here shown is mounted on top of a sidereal clock, kept in motion by a weight. Steam-engine governors were also exhibited by M. Eichens at Paris. In simplicity of parts the latter left little to desire.

STEREOTYPING WITH PAPER.

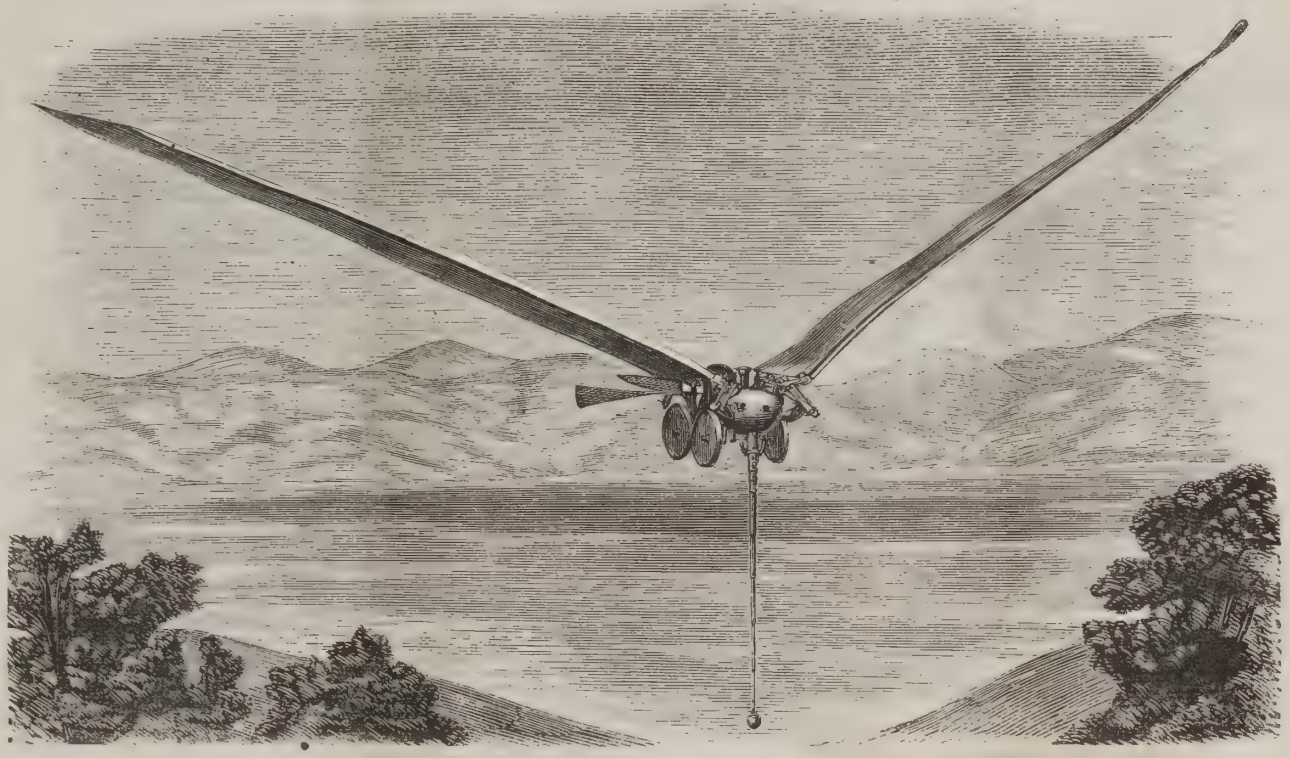
This is now in common use in all the principal daily newspaper establishments in New York. It is conducted substantially as follows:— The stereotyper first dries the forme of types upon an iron steam table. The forme is then partially unlocked, and a hand-brush is rubbed over the surface of the types, cleansing them preparatory to placing over the entire forme a sheet or sheets of thin bank note-paper, of the finest quality, previously wetted to insure the required pliability. This paper being evenly laid over the types, the workman takes a long-handled brush, made of short, stiff bristles, with which he beats the wet paper evenly, forcing it into all depressions of the types, taking care not to break the paper. The work finished, a dampened sheet of thicker but more ordinary paper is placed over the first. This is also brush-hammered down upon the types, and followed by another sheet of paper, thinly coated with a preparation of whiting and starch. Again the brush is used to beat this home, after which a brown paper backing is put on, and then the forme of types, covered by the before-mentioned sheets of paper, is trundled to another steam table, where it is slid under a powerful screw press, several blankets folded over it, and all firmly held down until the paper matrix is dry-hardened, or "cooked," as the workmen express it. The papering process occupies three or four minutes, the cooking about twice as many. The matrix is now peeled off from the forme, and prepared for casting by sifting it with finely powdered borax, which with a soft brush is thoroughly rubbed into the sunken surface left by the types. The surplus borax having been removed, the matrix (which now resembles hard but pliable pasteboard) is ready for the casting-box, which is made of iron, either straight or curved, to suit the press-bed. Handle irons hold the matrix in its proper place, at the exact distance (about half an inch) necessary for the thickness of the stereotype plate, which is made by pouring a quantity of hot type metal into an open end of the casting box. This metal, dropping between one surface of the casting box and the sunken surface of the matrix, fills up the latter without burning it. A few moments are allowed for cooling, and then the matrix is stripped from the warm plate, which is subsequently prepared for the press by trimming down all thick lines, or chiselling away any superfluous metal, paring off the

edges, filing, and otherwise treating the stereotype after the usual manner. Circular saws driven by steam power, and hand-cutting machinery of various kinds, are used in finishing, the whole operation of stereotyping occupying from fifteen to twenty minutes. A second plate may be obtained from the original matrix in about two minutes, and almost any number of castings can be taken by careful workmen. In some offices only one mould is taken, this being used for casting the number of plates required for several presses. The stereotype, being an exact reproduction, in solid plate form, of the million or more types originally put together by the compositors, is fastened upon the Hoe, Bullock, or any other printing press, and used in place of the types. The advantage of duplicating the plates is apparent. Two or ten presses, working similar plates, will print off in a couple of hours an edition of twenty or a hundred thousand copies, which formerly occupied so much more time that, when ten or twelve-cylinder "fast" presses became "slow," second and third editions were resorted to by editors desirous of giving the public the latest news. Previous to the use of stereotypes for newspaper purposes, duplicate formes were sometimes "set up" in type, an extra expense to the office adopting this course, which was incurred only whenever a pressure of important news was likely to prevent the formes going to a single press in season for working off the edition. Compositors can now work until three and four o'clock in the morning, and half an hour later half a dozen "duplicates" of their work may be seen on as many different presses, striking off the printed sheets, units of an immense edition of perhaps seventy-five or eighty thousand copies of some newspaper, all of which are frequently counted and delivered to the carriers and newsmen before the editors, compositors, or stereotypers can reach their homes and retire to rest.—*Paper Trade Review.*

KAUFMANN'S AERIAL LOCOMOTIVE.

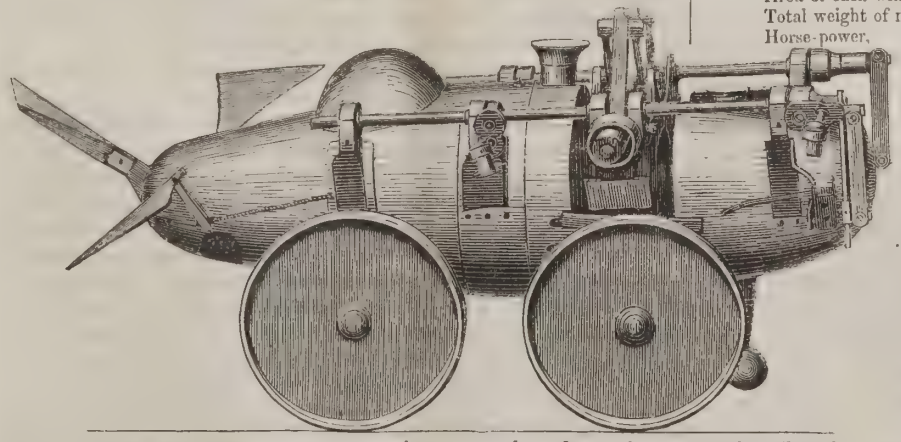
THE novelty of this machine consists in that it is designed to travel

Fig. 1.



principally through the atmosphere, performing aloft the part of a locomotive engine on the rails; and it is designed to move through water like a paddle ship by a few simple alterations, or travel on land like an ordinary carriage. The present engravings are taken from photographs by Mr. Downie, of Glasgow, which represent the model of one of the machines intended exclusively for land.

Fig. 2.



The dimensions are as follows:—

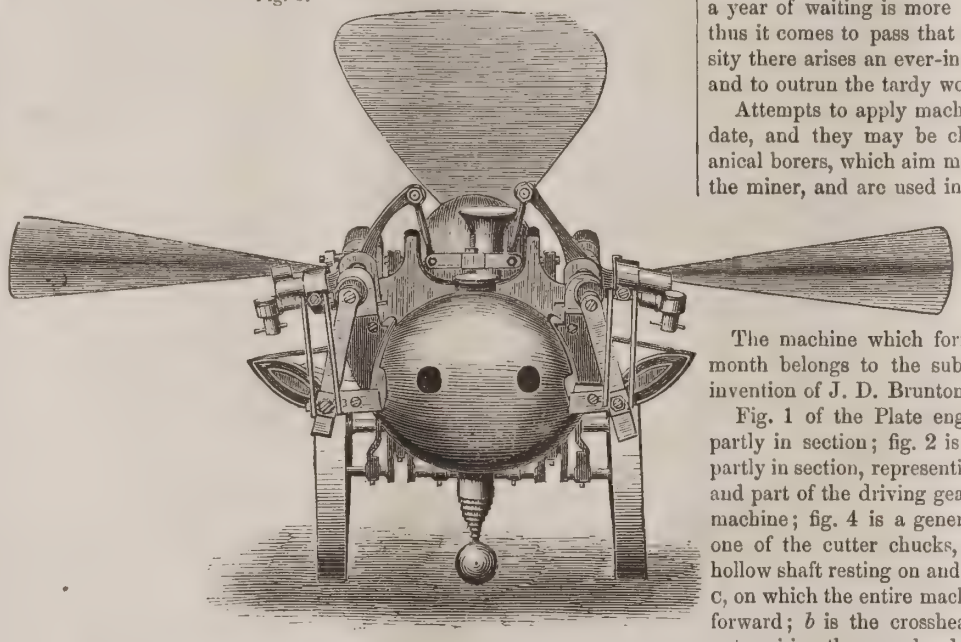
From stem to stern,	12 feet.
Diameter of greatest width,	5 feet 1 inch.
Depth in the centre,	4 feet 6 inches.
Length of each wing,	35 feet.
Area of each wing,	221 square feet.
Total weight of machine,	7000 lbs.
Horse-power,	50 nominal.

This machine, made on the large scale as given, is designed to draw a train, made according to Mr. Kaufmann's plan, of one tank car with five hours' supply of oil and water, and three cars containing twelve passengers in each, at a rate of 38 miles per hour, through any state of the atmosphere of less disturbance than a heavy gale.

The model of this machine, which was made and tried very recently, is of about one horse-power, and weighed (complete) only 42 lbs. It was constructed to prove the practicability of obtaining that indispensable combined oscillating and screwing motion of the wings as attached to the body, and without which the act of flying could not be effected. The engine consists of a direct-acting vertical cylinder, working the wing beams through the cross head and connecting rods, kept in position by a pair of guides; the main shafts drive the motions

which throw the wings in and out of position at each stroke. At the last trial, this machine was strapped down to some heavy planking and loaded with a considerable weight to prevent its moving, while the wheels were kept off the ground by means of supports. The experiment lasted but a short while, on account of the great force applied, 150 lbs. per square inch on the piston; the wings after some furious strokes gave way to the strain, which was greater than they were designed to resist, and thus had to be taken off. The machine was then put to work to prove capability of motion at a high speed; about 1500 revolutions per minute were obtained, and on after examination all the parts were found to be still in perfectly good working order. Altogether the trial, as witnessed by a number of engineers, was satisfactory; so much so, indeed, that Mr. Kaufmann is now constructing a machine and carriage of a power sufficient to carry several persons over land and water, irrespective of wind or weather. This last-mentioned machine is a considerable alteration from the first, and we may look forward to its appearance at the end of April or the beginning of May next.

Fig. 3.



CARBONIZING IRONSTONES.

All ironstones contain certain amounts of carbon, both combined and in the free condition. It has hitherto been the practice to drive off the greater part of this carbon, along with the volatile matters, by calcination, previous to the ores being used in the blast furnace. Now, by such calcination a large amount of valuable fuel is wasted; as many ironstones, particularly the black-bands of Scotland and Wales, contain enough fuel to effect their reduction in the blast furnace. Some experiments with the view of utilizing the carbonaceous matter of the ironstone, and thus saving the coal now employed in the blast furnace, have recently been made by Mr. Henry Aitken, of the Almond Iron Works, Falkirk—and we hear with very great success; some of the coked ironstone having had retained in it enough carbonaceous matter to reduce the ore without the use of additional fuel. We certainly can see no reason why the use of carbonized ironstone should not prove a complete practical success; if so, it will result in an enormous economy to our iron-masters, and tend to cheapen the price of iron considerably, thus constituting another step towards placing us on an equal footing with our competitors on the Continent and elsewhere.—V. D.

TUNNELLING MACHINE.

(Illustrated by Plate 16.)

In looking around over the vast field of human labour, and noting in what part of it invention has substituted mechanical operation for manual labour or skill, one may observe that in a department that is very laborious, and one lying too at the root, as it were, of many others, because it supplies them with their raw material, invention has done very little. Since gunpowder came to the help of the miner, he has been unhelped, and the epochs that have seen the tasks of his fellow-labourers in various degrees remitted, have brought no remission of his; but, as of old, so still; with the hammer and the pick, the borer and the blast, he slowly makes his way to the discovery of earth's secrets, and the acquisition of earth's treasures. And yet this is a kind of labour that the age needs especially to be done quickly; its railways and its water-works wait upon it: to an impetuous age like the present a year of waiting is more intolerable than a decade of working; and thus it comes to pass that from an ever-augmenting sense of its necessity there arises an ever-increasing urgency for machinery to supersede and to outrun the tardy work of the miner.

Attempts to apply machinery to mining are comparatively of recent date, and they may be classed under two heads:—First, the mechanical borers, which aim more or less at an imitation of the operation of the miner, and are used in connection with powder; secondly, tunnelling machines, properly so called, which may be subdivided into (a) those which still employ blasting, and (b) those which essay to remove the rock by their unassisted mechanical action.

The machine which forms the subject of our Plate engraving this month belongs to the subdivision (b) of the second class, and is the invention of J. D. Brunton, Esq.

Fig. 1 of the Plate engraving is a side elevation of the machine, partly in section; fig. 2 is a corresponding end view of the same, also partly in section, representing the working or cutting end of the machine and part of the driving gear; fig. 3 is a view of the opposite end of the machine; fig. 4 is a general plan; and fig. 5 is a detail face view of one of the cutter chucks, with one of the sockets or holders. *a* is a hollow shaft resting on and revolving in the bearings, *c c*, of the carriage, C, on which the entire machine is supported, and upon which it is carried forward; *b* is the crosshead cast or keyed upon the shaft, *a*. At its extremities the crosshead carries the arbors, *d d*, upon which revolve the cutter chucks, *e e*. That portion of the arbor on which the chuck rotates is excentric with the portion which is contained in the crosshead. *f f* are worm-wheels fixed upon the arbors, *d d*, and *g g*, are worms working into them. By means of the worms and wheels, and the excentricity in the arbor as already described, the chuck can be moved a small distance outward or inward, so as to compensate for any wear of the cutters, by which the diameter of the pit, tunnel, or gallery formed, might be diminished. The axis of the shaft, *a*, may be called the "central axis," and the axes of those parts of the arbors, *d d*, on which the chucks rotate, are designated the "planetary axes," and are equidistant from the central axis. The chuck, *e*, and the toothed wheel, *h*, are cast in one piece. *i i* are the cutters, of which six are attached to each chuck; *j j* are the pivots or journals on which they are at liberty freely to rotate; *k k* are the bolts holding them upon the pivots and in the sockets, k^1 k^1. These sockets are pieces distinct from the cutter chucks, and are fixed to them by bolts and nuts or screws, and are formed with slots to allow of the sockets being placed more distant from the centre as the diameters of the cutters are reduced by wear.

The angle at which the cutters are set with the plane of the surface of the rock or other substance to be cut may be varied, and should be such as to enable the cutters most effectively to act. The central spur wheel, *l*, gears into the wheels cast upon the back of the cutter chucks, *e e*, and is keyed upon a central shaft, *m*, concentric with, and passing along the interior of the hollow shaft, *a*. The shaft, *m*, revolves in proper bearings provided at each end of the shaft, *a*, and upon its outer extremity there is keyed a bevel wheel, *n*, into which gears another bevel wheel, *o*, which receives its motion from the prime mover by a wire rope and pulley, *p*. Upon the hollow shaft, *a*, is keyed a worm wheel, *q*, into which gears a worm, *r*, which causes the wheel, *q*, and the shaft, *a*, to revolve by means of the pulley, *s*, and the bevel wheel and pinion, T, *t*. The pulley, *s*, is driven by a belt from the pulley, *o'*, upon the shaft, O. It will be seen that the "planetary motion" of the cutters is effected by the revolution of the shaft, *m*, and that the motion of the planetary axes round the central axis (or "orbital motion") is caused by the revolution of the shaft, *a*. The relative speed of these shafts will regulate the "feed" supplied to each cutter, or in other

Fig. 2.

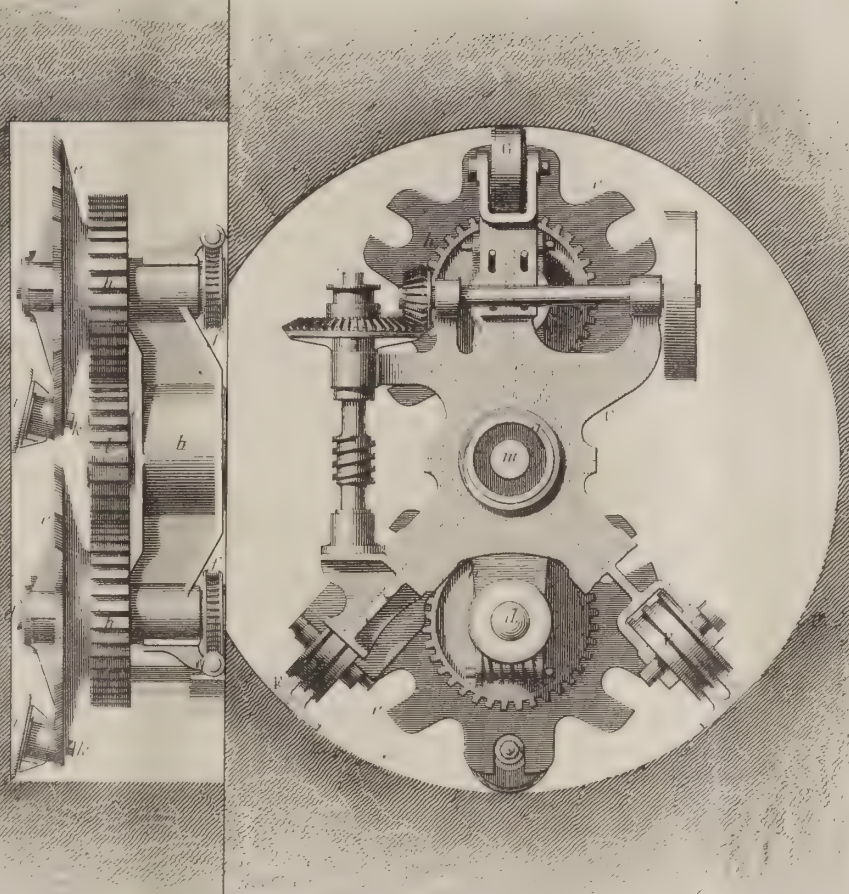
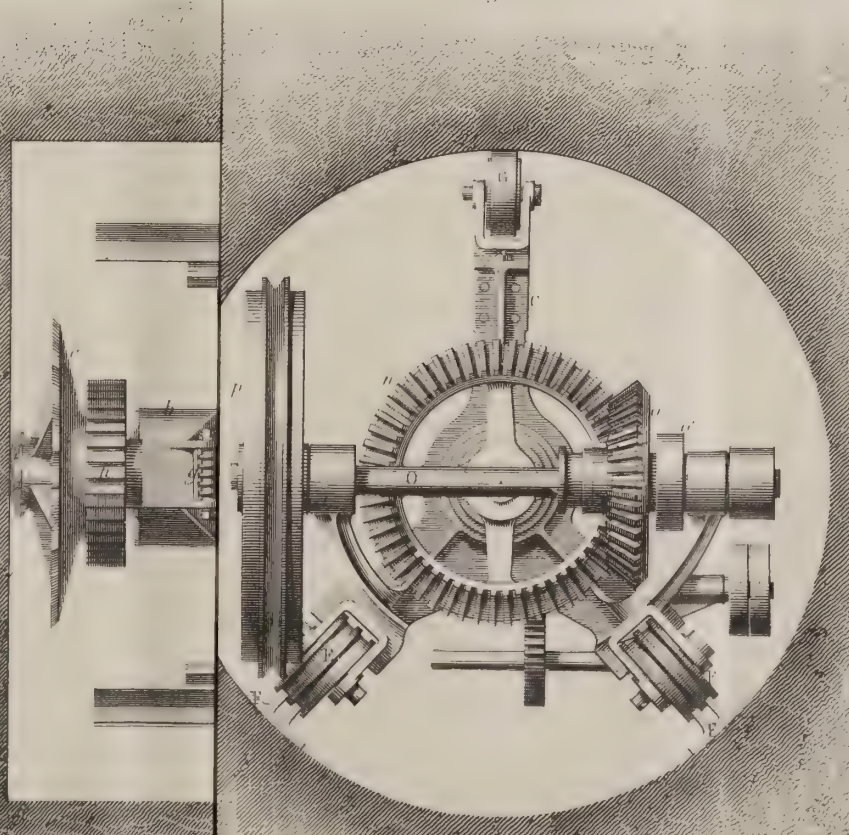


Fig. 3.



TUNNELLING MACHINE.

J. D. BRUNTON, ENGINEER.
PATENTEE

Fig. 1.

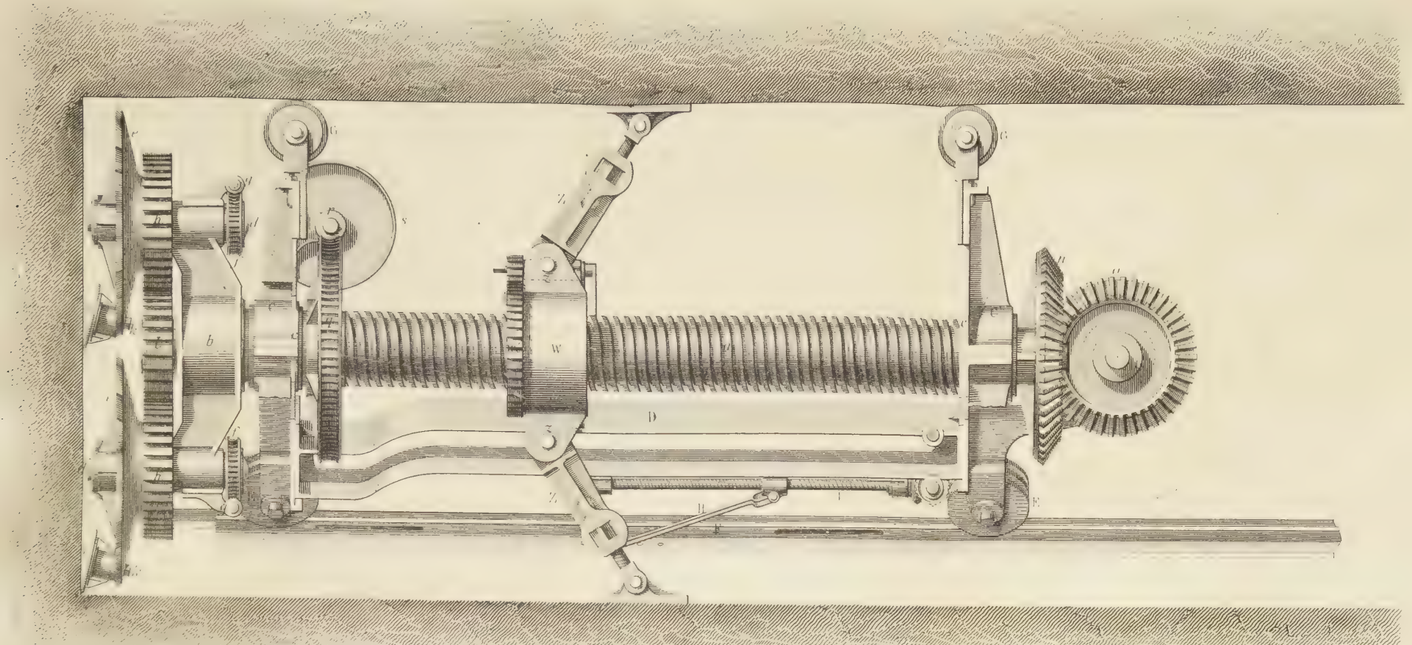


Fig. 2.

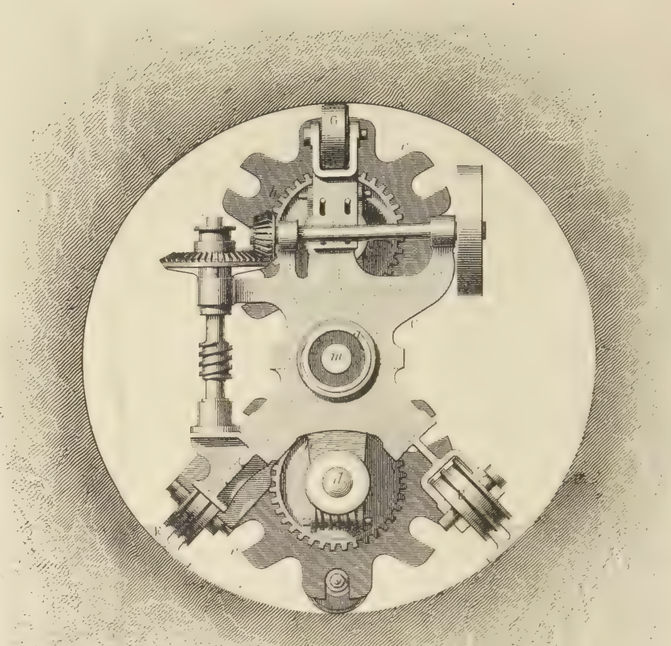


Fig. 4.

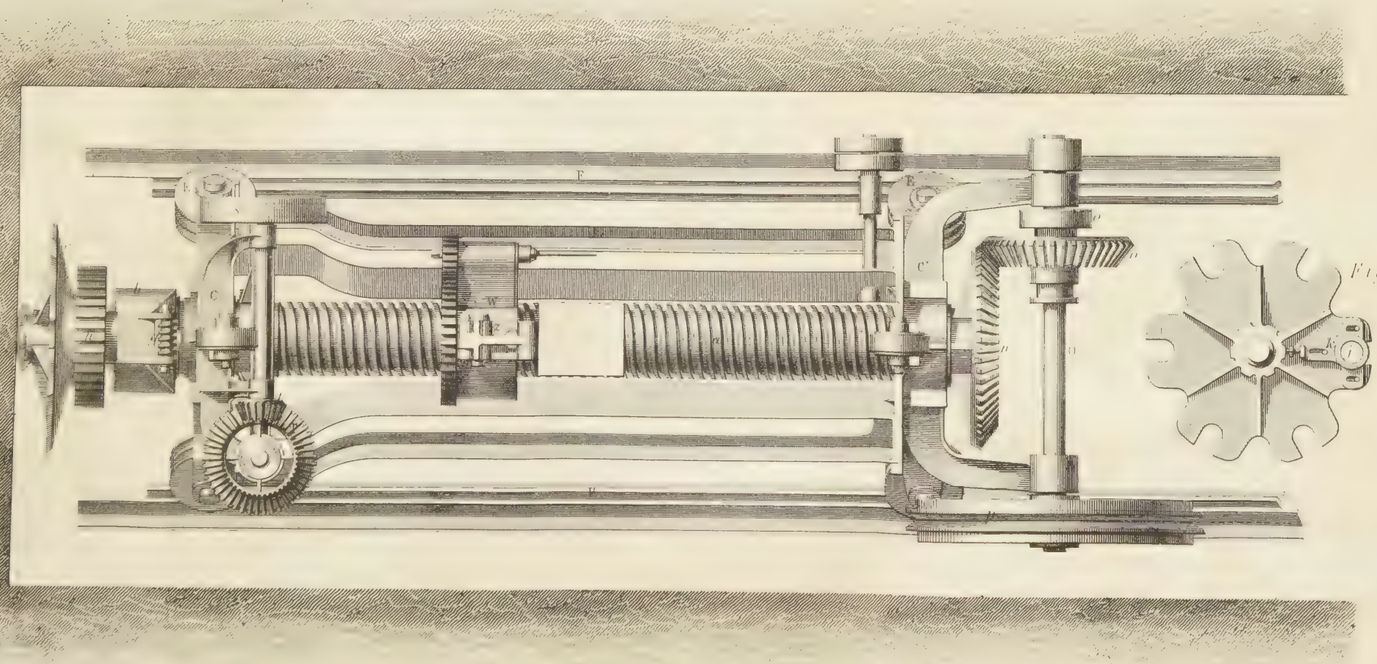
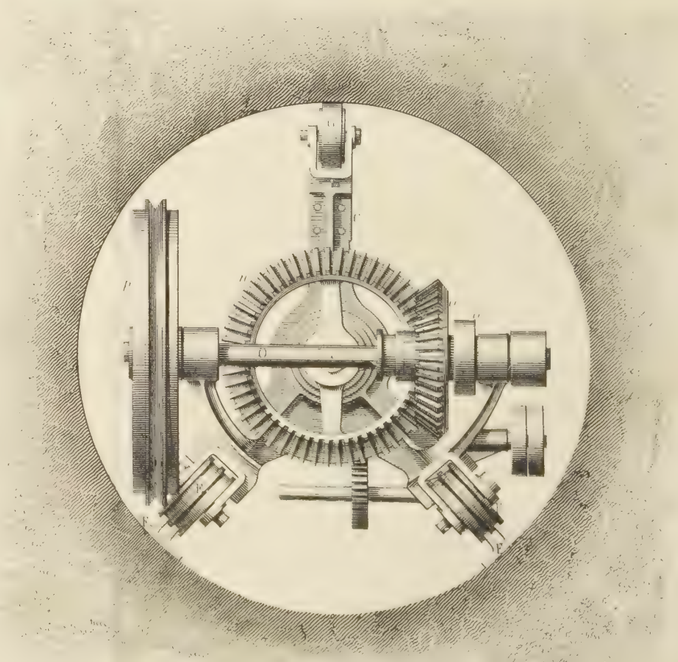


Fig. 5.

Fig. 3.



SCALE

words the advance which each cutter makes beyond that which preceded it.

Upon the external circumference of the hollow shaft, *a*, is formed a screw, upon which is placed a nut, having a toothed wheel, *w'*, cast upon it: the outer circumference of the nut is turned to receive a collar. The nut and collar, W, can be held together by means of a key, so that the one cannot revolve without the other. Upon W are cast two or more lugs, *z z*, which carry arms, Z; the outer ends of these arms are furnished with a screw and foot plate. By means of the screws these plates are brought into contact with the internal surface of the tunnel or gallery; and the effect of the screw on the shaft, *a*, when the machine is in operation, is to jam firmly the arms, Z Z, in the tunnel or gallery, and so to constitute the nut, with its collar, W, a fulcrum or fixed point from which the whole machine is forced forward against the face of the tunnel by the revolution of the shaft, *a*. When *a* has been screwed through the nut to the end of the thread upon it, the machine is stopped; the key is slackened, and by means of handles, and the pinions working into the wheel, *w'*, on the nut, the nut is screwed forward again to the inner end of the thread upon the shaft, *a*, carrying with it the collar, W, and arms, Z Z. A set screw working in a groove in the circumference of the nut prevents the collar, W, from slipping off the nut, at the same time that (in the slackened state of the key) it allows the nut to revolve without carrying the collar and its arms round with it. The combined orbital and planetary motions, as described, together with the forward motion produced by the screw acting against the fixed nut, cause the cutters to cut the face of the tunnel or gallery into a spiral form, having its pitch or angle of progress equal to the pitch of the thread upon the shaft, *a*.

The cutters, *i i*, are discs of steel or other suitable substance, and may be from 10 to 20 inches diameter, and from ½ to 1 inch thick, according to the size of the machine and the nature of the rock or ground operated upon. The whole circumference of their periphery is formed into a cutting edge, and they are placed at right angles to their planes upon the pivots or journals, *j j*, which, with the cutters, rotate freely in the sockets or holders, *k' k'*. The radius of the circle described by the edge of the cutters in their action upon the rock should be about one-half of the radius of the cylindrical tunnel or gallery to be formed, so that in every orbital revolution the cutters shall pass over and cut from the entire, or almost the entire, face of the end.

C C' indicate the carriage, which consists of the fore part, C, the back part, C', and the side beams, D D, connecting the fore and back parts; E E are double-flanged wheels, rolling on two pairs of rails, F F. Uprights, on the fore and back carriage, support rollers, G G, which are set firmly against the roof of the tunnel or gallery, and contribute to keep the machine steadily in a central position.

The rails, F F, lie on the floor of the tunnel or gallery, and are moved forward in alternate pairs along the floor by means of the thrusting bars, H H, which drop into holes made in the flange of the rails, and which can be set in motion by means of the nuts, I I, upon the screws, J J, actuated by a belt from the shaft, O, and the intermediate bevel and spur gear. By this means a continual rail track is provided for the machine as it advances.

By the divergence of the centre lines of the arbors, *d d*, from the plane of the central axis, provision is made for the clearance of the cutters from the face of the rock during that part of their revolution in which they are not cutting.

The descriptive reference will have made the movements of the several parts, and their relation to one another, intelligible, and it will be seen that there is no concussion, but that the motion is circular and continuous. It will be obvious also that the shape of tunnel produced by a machine such as represented is cylindrical. The face or end of the tunnel becomes of a double spiral form, with a step which is always maintained, and against which the cutters act, splitting off pieces from the face.

Attrition between the steel cutters and the rock is reduced to its minimum. As much as possible, the action is made one of simple pressure, thus reducing the question between the steel and the stone to this, *which will crush first?* It is well known that a grindstone, which will rapidly cut by attrition any steel presented to it, would be reduced to powder under a pressure that would not affect the steel. In the machine now under consideration the aim is to take full advantage of these different capabilities in steel and rock to resist compression.

As the cutters describe their circular path upon the end of the tunnel, they cut their way inward by virtue of the forward motion imparted by the central hollow screw shaft, and as they get deeper and deeper, a circular fronted step gets formed before them. The height of this step will depend on the pitch of the great screw, although this may be modified by giving to the nut a differential motion, and it may vary from half an inch in granite to 2 inches in a soft rock; but whatever it is, the forward spiral motion of the machine maintains it. Nor is it difficult to maintain by the means employed. If a step of 1 inch in height be taken as an example, in a tunnel of 7 feet diameter, an advance or feed of $\frac{1}{7}$th of an inch being given to each cutter beyond that which preceded it, we shall then have 924 cuts to effect the penetration of 1 inch.

The machine, as shown in the plate, has two cutter chucks, each of them, with its six cutters, one only being shown in position, producing its own step. Therefore, if each takes a step of 1 inch, a progress forward of 2 inches will be made by each revolution of the screw shaft. Experience has shown that the cutter chucks may make at least 40 revolutions per minute in rock not harder than mountain limestone. Such a speed, with a feed of $\frac{1}{7}$th of an inch, gives a progress in the tunnel of 2 inches in $4\frac{1}{5}$th minutes.

It is to be observed that the whole task prescribed to the machine at any moment is at two points to penetrate a $\frac{1}{924}$th of an inch, and to effect an advance of $\frac{1}{7}$th of an inch against a resistance no greater than can be offered by a slip of stone of one inch in height. The cutter rolls its edge at the foot of the slip, and avoiding, as much as may be, any attrition, for in that conflict it would be worsted, as it makes good, by quiet but irresistible force, its 7th of an inch advance, the slip gives way, splits off at an angle, and the next oncoming cutter has but little to do.

It has been said, and it will be said again of all tunnelling machines that propose to reduce the rock to small pieces, that there is a great and needless waste of mechanical power: much less must be expended, it is said, if holes be made by machinery, the rock blasted, and removed in considerable masses.

The assertion is made very confidently, and its truth is usually taken for granted. But let us look at this point for a moment, and for our guidance, let us take the facts of the operation now being carried on in the Mont Cenis Tunnel. The drift is about 10 feet square, and 80 holes, of an aggregate area of about $\frac{1}{78}$th part of the area of the end, are made by the borers. A 78th part then of the whole bulk of rock extracted is reduced to exceedingly fine powder. It is not too much, probably, to say, that of such particles there would be 100,000 in a cubic inch. The question then assumes this shape. Suppose that by the tunnelling machine we have been describing the fragments average 1 cubic inch in bulk (and this is less than the fact): to reduce 78 tons of rock to pieces of the bulk of a cubic inch, or *one* ton to pieces 100,000 times as small, in which operation is there the greatest expenditure of mechanical power?

The writer does not know whether there is any dependable data to go upon to determine such a question. The practical working of this machine may supply it. Meanwhile, it is plain that judgment on the matter cannot go by default. The foregoing comparison is purely between the relative forces expended by the two classes of machines, but to the force employed by a boring machine should be added the force developed by the powder used; and it should be ascertained also what additional force would be put at the disposal of the tunnelling machine, by the consumption of as much coal as would be equal to the value of the powder. It will be thus seen that a tunnelling machine might require a good deal more power than a drilling machine, and yet stand favourably in the comparison, not to speak of the advantage which must always attend a machine that can work uninterruptedly as compared with one that has to be frequently withdrawn for the operation of blasting.

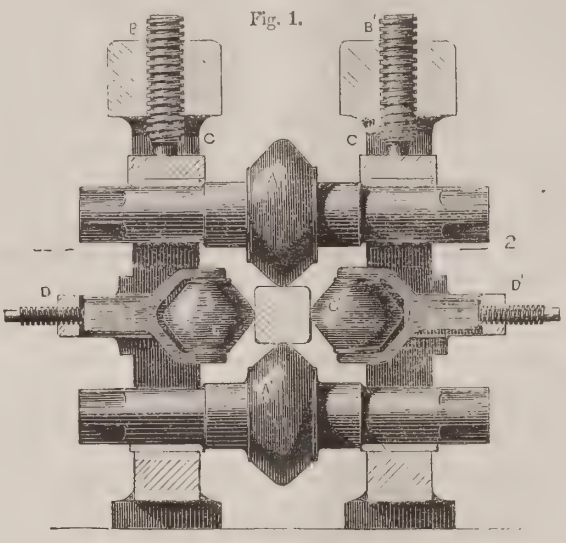
A machine upon the plan shown in Plate 16 is already constructed, and a tunnel of considerable length in the slate rock of North Wales is about to be driven by it. We hope, in an early number, to be able to tell our readers what it has accomplished.

ROLLING METALS.

A VERY ingenious arrangement of rolling mill for producing X-shaped and other forms of girders, pillars, &c., has recently been patented by

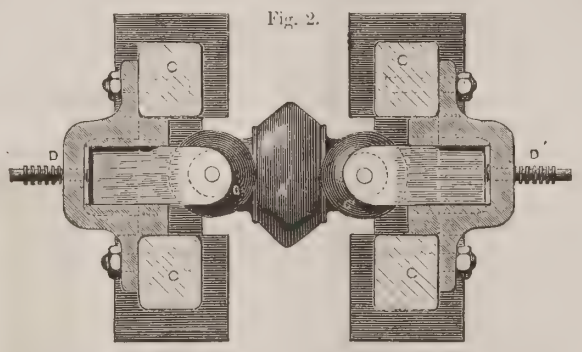
MM. Hippolyte U. Petin and Jean Marie Gaudet, of the firm of Petin, Gaudet, & Co., of Rive-de-Gier. The patentees employ four rolls of shapes varying according to the section of iron desired to be produced.

Fig. 1.



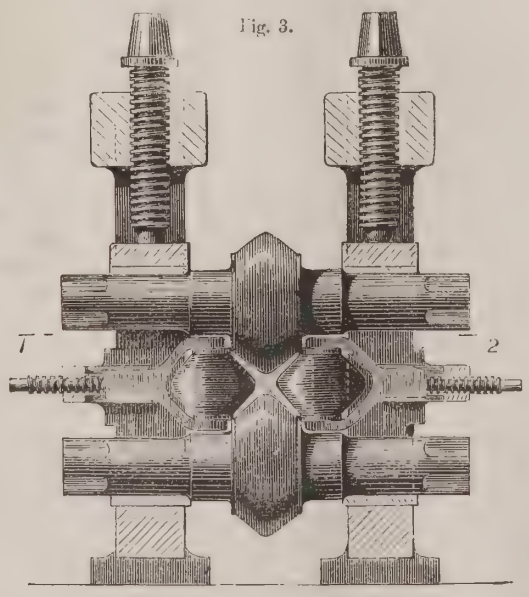
After each passage of the metal, the top roll and two horizontal rolls are moved inwards slightly by means of powerful adjusting screws or other suitable contrivance, so as to nip the metal equally on all four opposite

Fig. 2.



sides. The horizontal rolls are contained in strong movable frames or supports, which are capable of sliding vertically along the main standards of the rolling mill, so that as the top roll is lowered the two horizontal

Fig. 3.



rolls may not only be made to approach each other, but to descend slightly, in order to keep them always in a central position between the top and bottom rolls.

Figs. 1 and 3 of the engravings are sectional elevations of a rolling mill, showing the rolls, which are of the requisite form for making bars of cruciform section, adjusted to different positions; and fig. 2 is a horizontal section of the mill taken on the line 1—2, and corresponding to the position fig. 1. In these figures, A and A^1 are respectively the top and bottom rolls, which are driven in any convenient manner, and G and G^1 are the rolls, which revolve horizontally on spindles, g and g^1, by frictional contact with the metal whilst undergoing the operation of rolling. The top roll, A, is adjusted after each passage of the metal by means of the screws, B and B^1, and the two horizontal rolls, G and G^1, are adjusted by means of the screws, D, D^1. The rolls, G, G^1, are contained in the movable frames or supports, E, E^1, which are capable of sliding along the main standards or frames, C, C, of the rolling mill, so as to admit of their vertical adjustment in order to keep them in a central position between the top and bottom rolls, A and A^1.

MECHANIC'S LIBRARY.

Cameron's Directions for Reading the Barometer. 8vo, 5s., cloth.
Cassell's Handbook of Chemistry. Foolscap, 1s., cloth.
Dillon and Barton's Commercial Reckoner. 8vo, 7s. 6d., cloth.
Free-hand Drawing. Nimmo. 12mo, 1s., sewed.
Hudson's Practical Plane and Solid Geometry. 4to, 4s., limp.
Metals and their Uses. Joynson. 12mo, 1s., sewed.
Rossiter's First Book of Algebra. 12mo, 2s. 6d., and Key 2s. 6d.
Ventilation of Dwelling Houses. Edwards. Royal 8vo, 10s. 6d., cloth.

RECENT PATENTS.

INDICATING MEASURE TAPS.

R. W. Ridley, *of Birmingham, and* J. Withers, *of Handsworth.—Patent dated 30th April*, 1867.

The object of this invention is, by the means hereinafter described, to construct a tap or cock for drawing off liquids, which shall at the same time indicate the quantity of liquid so drawn off.

The first part of the invention relates to the formation of the tap, which consists substantially of an inner, hollow, cylindrical, or, by preference, slightly conical body or chamber, working with exactness in an outer casing of corresponding shape, placed horizontally in a suitable framework. The outer casing has two holes or apertures of corresponding size provided therein; one being the inlet passage, and being by preference at the top part of the casing, and the other the outlet passage, being by preference at the bottom of the casing. The inner body or chamber is provided with one or more corresponding apertures; and being turned round so as to allow one of its apertures to correspond with the inlet passage provided in the outer casing, the liquid is free to flow until the inner chamber is filled; the inner chamber being then turned so as to allow one of its apertures to correspond with the outlet passage in the outer casing, the liquid will discharge itself or run off. In this manner it will be obvious that only one of the passages can be open at the same time; that is to say, when the inlet passage is open the outlet passage must be closed, and *vice versa*.

The inner body or chamber herein described is supposed to be equal in capacity to some known liquid measure, so that each time it is filled and emptied a certain known quantity of liquid shall have passed through.

The second part of the invention has reference to the manner of indicating the quantity of liquid which has been drawn off in the manner hereinbefore described. The inner body or chamber is turned round as required by a handle affixed to the one end thereof. Upon its other end is affixed a small spindle or axis, of just sufficient length to project through the end of the outer casing, upon the end of which is fixed a plain wheel, with a spring catch attached thereto, and which is so arranged that when put in motion by the turning of the inner chamber it will act upon a ratchet wheel attached to an indicator, upon the axis of which is a pinion wheel giving motion to a suitable train of wheels (somewhat after the manner of the counter of a gas meter). On the axis of the said wheels are placed hands or pointers, which, by means of suitable indices or dials, indicate the quantity of liquid drawn off, whether in units, tens, hundreds, or the like.

Although only one indicating tap has been mentioned, it will be apparent that any required number may be affixed to the framework herein

referred to. In this manner it is possible to have in one apparatus several taps, all indicating a different capacity of measurement.

Fig. 1 of the engravings represents a vertical section of a series of three of the improved indicating measure taps, fitted into a suitable frame or support; fig. 2 is a transverse vertical section taken along the line 3—4 in fig. 1. A represents a frame or holder, which is intended to be screwed down or otherwise secured to a counter, or other convenient support; in this frame is mounted one or a series of measure taps. As each tap is precisely similar, it will only be necessary to describe the construction of one of the series. B is the outer case or body of the tap, which it is preferred to make slightly tapered, with a view to the better fitting of the plug, C, therein, which plug is made hollow, and forms, in fact, the measuring vessel, its capacity being equal to any given fluid measure. On diametrically opposite sides of the outer

Fig. 1.

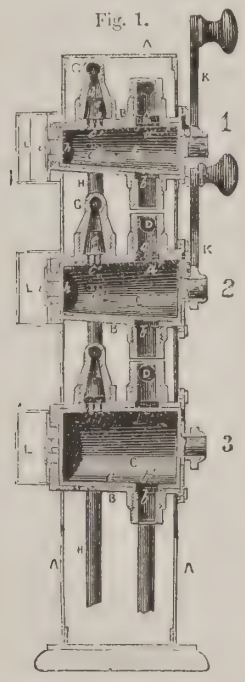
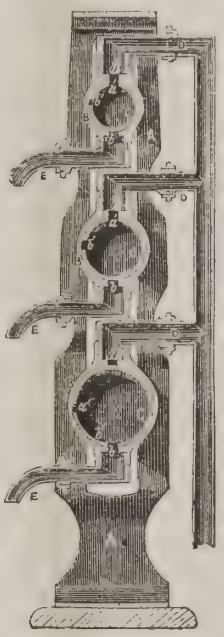


Fig. 2.



case, B, there are made two openings, *a* and *b*, the one, *a*, serving as an inlet, and the other, *b*, as an outlet. These openings are in communication respectively with the inlet branch pipe, D, and the outlet pipe or discharging nozzle, E. The several inlet pipes, D, when a series of taps are used, open into one common main pipe, F, which leads to the source of supply; and if desired, the several discharge nozzles, E, may also open into one pipe common to the series. A third opening, or group of openings, C, is made in the case, B, which serves as an air vent, as hereinafter described. In the plug, C, are formed two openings, *a′* and *b′*, situate on the same circumference, but at rather less than 90° from each other, or say half the width of the opening less. It will, therefore, be evident that in order to bring the outlet opening, *b′*, of the plug, C, from the position shown in the cock, No. 1 (which is in the act of filling) to the position shown by the cock, No. 3 (which is emptying), it is necessary to turn the plug rather more than a quarter of a revolution, the object of which will hereafter be explained.

Air holes, *c′ c″*, are also made in the plug, in such a position as to coincide with the vent holes, *c*, in the case when the plug is turned into the position either for filling or emptying, the object in the first case being to allow of the displacement of the air in the plug by the incoming liquid, and in the other case to allow the air to enter the plug as fast as the liquid flows out. The air vents, *c*, of the series of taps communicate by means of the conical valve chambers, *d*, and branch pipe, G, with the main air pipe, H, which always remains open to the atmosphere. Inside each valve chamber there is provided a conical valve, *e*, of cork, or other suitable material, which valve will be raised, and will close up the mouth of the branch, G, so soon as the liquid which has filled the plug commences to flow through the vent holes, *c*, and will consequently prevent any escape or loss of the liquid down the vent pipe, H. When the plug, C, is turned for the purpose of emptying its contents, the valve, *e*, will be opened or forced from its conical seat by the pressure of the atmosphere, and air will enter the hollow plug, and take the place of the liquid as it flows out.

A metal cap or cover, I, for securing the plug, C, in its place, is screwed on to the front end of the case, B, of each tap, and through the centre of this cap passes the spindle of the hollow plug or measurer, C. To this spindle is keyed any convenient form of handle, K, which is provided with a stop pin, working in a segmented slot, *f*, made in the cap or cover, I, in order to prevent the plug, C, from being turned too far. As the hollow plug or measuring vessel, C, is of a known capacity, and is emptied each time the handle, K, is turned downwards, it follows that by registering the number of times such plug is emptied the aggregate quantity of liquid drawn off may be ascertained at any time. To accomplish this the plug of each measure tap is connected with a counting mechanism, L, of its own situate at the back of the frame, and if desired covered in so as to be under lock and key.

WOOD SCREWS.

JOHN HENRY JOHNSON, *London and Glasgow.—A communication from* J. W. HOARD and S. W. YOUNG, *Providence, Rhode Island, U.S., A.—Patent dated June* 17, 1867.

THIS invention relates, firstly, to wood screws, and particularly to those known as "gimlet pointed" screws, and consists in forming in the shank of the screw one or more longitudinal grooves, flat sides, or indentations, which extend upwards from the point of the screw and are transverse to the thread of the same. By this means one or more cutting edges are produced in the screw, which, by removing the wood, materially assist the entrance of the screw, more particularly in very hard woods, and enable the screw to be driven or inserted without the necessity for first boring a hole to receive it, as the screw is its own boring tool and makes its own hole as it is inserted.

The second part of the invention has reference to the tools for cutting the threads on the improved or other wood screws, and consists in the employment, for that purpose, of a cylindrical or other suitable curvilinear form of tool, whether a complete cylinder or only a segment of the same. This tool has a series of parallel ribs or projections formed longitudinally upon its curved surface, of a transverse section corresponding to the transverse outline of the spaces between the threads to be cut on the screw. The cutting end of the tool, which may be made either tubular or solid, is hollowed out or bevelled inwards so as to leave sharp points at the extreme ends of the longitudinal ribs, such points forming the chisels or cutting edges which remove the superfluous metal from the screw blank in the operation of cutting the threads. The peculiar cutting tool is mounted in an ordinary or suitable holder or chuck, and as the screw blank revolves in contact with the cutting points the latter remove the metal gradually from between several threads at the same time, by reason of the curvilinear form of the tool, and thus the work is accomplished more rapidly and effectually than by the use of the ordinary existing screw cutting tools. This tool may be sharpened when requisite, by simply deepening the bevelled hollow at the end of the tool.

Fig. 1.

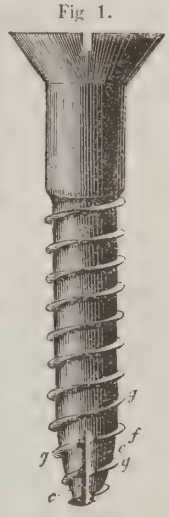


Fig. 2.

The engravings represent an elevation of a screw with grooves in its lower end, and a transverse section of the same. The action of the ordinary wood screws when entering the wood is to jam the same away, or aside, its small end or point entering the wood first, being followed by the gradually swelling shank, which compresses the wood and forces it aside; this renders the insertion of the screw into hard or close-grained wood very difficult and laborious, oftentimes causing the screw to be broken, and subjecting the wood to the liability of being split or cracked by the screw. To remedy these and other defects, I form the screw so that instead of compressing the wood it shall cut its own way, dispensing with the use of gimlets or other tools to bore the hole before the screw is inserted; extending upwards from the screw point is a series of grooves, *f*, the number of which may vary, though it is found best to adopt three, as shown in the drawing. The course of the grooves is

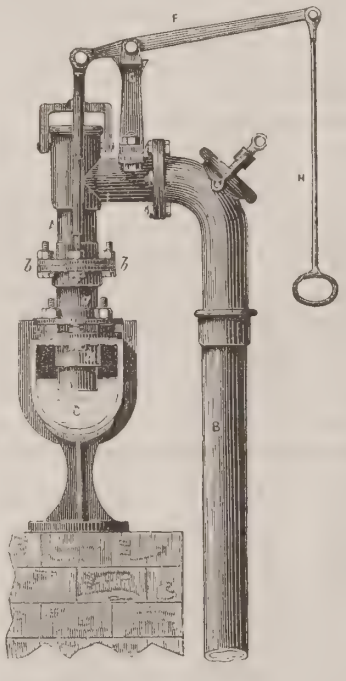
transverse to that of the screw thread, *g*, and consequently at the point where the latter is intersected by the grooves a cutting edge, *c*, is formed, which materially aids the screw in its passage through the wood. When the screw enters the wood the edges, *c*, cut their way and the screw gradually advances, not by compressing the wood but by cutting its path, thus displacing the wood with much greater ease than is the case with the ordinary screw. The screw, when completed by the machine herein referred to, presents a more perfect and neat appearance than one cut by ordinary means, by reason of the metal between the threads being more gradually cut.

SEAL OR DIP PIPES FOR GAS RETORTS.

H. & F. C. Cockey, *Iron Works, Frome.—Patent dated 28th May*, 1867.

This invention relates to a peculiar construction and arrangement of what is called the seal or dip pipe in connection with gas and other retorts, whereby the seal pipe can be shifted or unsealed as soon as the retort is charged, so that all pressure on the retort caused by the seal or dip of the pipe is at once removed.

It is applicable to any shifting pipe whereby this object can be obtained, but by preference the pipe is made telescopic, and raised out of the tar or liquor in the hydraulic main by means of a lever and rod fixed in such a manner that the man charging can, as soon as he has closed the retort, raise the seal pipe out of the tar or liquor, and thus unseal it, and before opening the retort for charging he can lower the pipe again into the tar or liquor, and reseal it; arranged in this manner the seal pipe also acts as an expansion sliding pipe between the retort and the hydraulic main.



On the engraving, A is the seal or dip pipe in connection with the ascension pipe, B, and with the hydraulic main, C. The lower portion, *a*, of the dip pipe, or that which enters the hydraulic main, is made to slide freely over the upper portion, such sliding part working through a stuffing box, D, on the hydraulic main. The raising or lowering of the telescopic or shifting part, *a*, of the dip pipe with a view to the unsealing or sealing of the same as may be found desirable, may be accomplished in various ways; but the arrangement shown in the drawings is preferred, which consists of a forked rod or link, E, coupled to opposite edges of the flange, *b*, of the movable part of the dip pipe, and connected at the upper end with one end of a lever, F, working on a fulcrum in a bracket, G, secured to the pipe. To the opposite end of this lever there is connected the rod, H, having a handle formed at its lower end, by pulling which the attendant can readily elevate or unseal the dip pipe as soon as the retort has been charged and the lid screwed on, and thus take off from the retort the pressure caused by the gas having to pass through the tar in the hydraulic main, as has heretofore been the case previous to loosening the lid of the retort; in order to recharge, the dip pipe must be lowered so as to seal it, and prevent the gas from passing back into the retort. It is obvious that the sealing and unsealing of the dip pipe may be effected by having an opening formed on the side thereof, above the level of the tar, but inside the hydraulic main; such opening being provided with a valve or cover in connection with a rod or other appliance for readily opening and closing the aperture as required.

LAW REPORTS.

* Betts *v.* Neilson and Others.—Capsules.—Before the Lord Chancellor, February 8, 1868. The bill was filed to restrain the defendants from using and selling in England capsules made of a material or combination of lead and tin, discovered and invented by the plaintiff; and it alleged that the firm of J. and R. Tennent, brewers at Glasgow, and manufacturers and exporters of bottled beer in large quantities, had been in the habit of covering their bottles with capsules of the same construction and material as those manufactured and patented by Mr. Betts, and of sending such bottles to their agents at Liverpool and London for transhipment to India and China. The defendants contested the validity of the patent on the ground of anticipation by prior user of the invention under a patent taken out by one Dobbs in 1804; and also that, even assuming the validity of the patent and the infringement of it by the capsules used by them, the mere transhipment of the cargo at Liverpool or London from the Glasgow vessel to that sailing for the foreign port to which the cargo was consigned, was not such a user of the invention in this country as to constitute an infringement within the jurisdiction of which this court could take cognizance. It was held by Vice-chancellor Wood that the defendants had failed to establish such a user of the invention patented by Dobbs as would invalidate the plaintiff's patent by anticipation; and that having regard to the nature of Mr. Betts' invention, there had been such a user of it in this country as to justify the interference of the court. The defendants appealed.

Mr. G. M. Giffard, Q.C., Mr. Wickens, and Mr. Aston were for the appellants; Mr. Willcock, Q.C., Mr. Grove, Q C., and Mr. Everitt for the plaintiff.

The Lord Chancellor said that the two principal questions were whether the patent of Mr. Betts was a valid one, and whether the defendants had been guilty of an infringement of it. The patent had been for many years the subject of litigation, particularly in the case of Betts *v.* Menzies, and, from the conflicting nature of the evidence, it had become a task of no little difficulty to discover the truth. After a full consideration of the scientific and other evidence, however, he was of opinion that the invention patented by Dobbs was not such a publication of the specification of the plaintiff as to invalidate the patent of the latter, and that there had been no prior user of the plaintiff's invention. The question then arose, whether the defendants had been guilty of infringement. The firm of which the defendant Neilson was manager sold beer for exportation only, and it was insisted on their part that as the sale of the beer took place in Scotland there was no active use of the capsules in England which could constitute an infringement. It did not appear to the court necessary to consider whether Messrs. Tennent were in possession of the capsuled beer at the time it was in England. The infringement of a patent was a tort, and all persons acting towards it were answerable. The capsules were not used merely for ornament, but for the purpose of excluding air and dampness. The employment of an article for the purpose for which it was designed constituted its active use; and the whole time these capsules were in England they might be said to be in active use for the very object for which they were placed on the bottles by the vendors. It could not be said that there was no user because England was not the final destination of the articles. There had been an active use of the capsules by those who first placed them on the bottles and by those who had them in their possession afterwards, and therefore he (the Lord Chancellor) agreed with the court below that the defendants had been guilty of an infringement of the patent. With regard to there being a decree for an inquiry as to damages as well as for an account, since the passing of Lord Cairns' Act there was nothing to prevent the court awarding damages as well as an account, where full relief could not otherwise be obtained. In the present case he agreed with the Vice-chancellor that the plaintiff was entitled to both these means of relief. The decree of the court below must be affirmed, and the appeal dismissed with costs.

Betts *v.* De Vitre and Others.—This case also involved the question of the validity of Mr. Betts' patent, the defendants being the Wimshurst Patent Metal Foil and Sheet Metal Company, and the Directors of that Company. The court below held that there had been an infringement of the patent, and granted an injunction to restrain the defendants from manufacturing any material similar to or only colourably differing from the combination of lead and tin invented by Mr. Betts.

Sir R. Palmer, Q.C., Mr. Haddan, Q.C., and Mr. Kekewich were for the appellants; Mr. Willcock, Q.C., Mr. Grove, Q.C., and Mr. Everitt for Mr. Betts.

The Lord Chancellor said that in this case the questions involved were precisely the same as those in the case of Betts *v.* Neilson, while the evidence in both was so similar in character that he might refer to the judgment he had just delivered for his decision in the present suit. With regard to the question of the personal liability of the directors of the Wimshurst Patent Metal Foil and Sheet Metal Company, it had always been held that a master was responsible for all the acts of his servant which were done in the execution of his duty. The alleged infringement took place in the company's works. It was not sufficient for the directors to order that the work should be so performed as that no injury should be done to any third person; they were bound to take care that their orders were obeyed, and they must be held liable for any violation of those orders, whether open or secret. The decree of the Vice-chancellor must be affirmed, and the appeal dismissed with costs.

Bovill *v.* Goodier.—The Flour Grinding Patent.†—Before Mr. Justice Byles and a Special Jury. January and February, 1868. The case came before the court in the shape of an issue sent by the Master of the Rolls to this court to try substantially the novelty of the invention claimed by the plaintiff in his patent of 1849 for improvements in machinery applicable to flour mills. On the first trial

* See *Practical Mechanics' Journal*, vol. i., Third Series, pp. 115, 149.

† For reports of proceedings in Bovill *v.* Keyworth, see *Practical Mechanics' Journal*, vol. ii., Second Series, p. 309; and Bovill *v.* Crate, see *Practical Mechanics' Journal*, vol. iii., Third Series, p. 147.

the defendant succeeded in obtaining a verdict on one of the questions, but the Master of the Rolls, not being satisfied with that verdict, directed the issue to be tried again.

The plaintiff is an engineer at Millwall, and took out the patent in 1849, and subsequently restricted his claim by a disclaimer of certain things which ought not to have been included in it. In 1863 he obtained five years' extension of the term originally granted by the patent, which will expire next June. From 1849 down to the present time the patent has been assailed in every possible way by combinations of interested persons, and yet for nineteen years it has withstood all adverse shocks. It has been the subject of many actions, nearly 100, and never hitherto been upset, and now, according to the plaintiff's evidence, at this the eleventh hour, the pecuniary interest at stake is over £100,000, and as Mr. Justice Byles told the jury, never, in all probability, would they again by their fiat have to dispose of so great a cause.

The following is a summary of the claim of the plaintiff's patent under three heads—first, fixing the top millstone and causing currents of air, either by exhaustion or pressure, to pass between the grinding surfaces of millstones, when the top stone is so fixed, and in the introduction of the ventilating pipes in the stones, as in the specification more fully described; secondly, in exhausting the dusty air when the same has been blown through the grinding surfaces of the millstones from the stone cases or chambers receiving the meal, as also more fully described; and, lastly, the plaintiff claimed the passing of the dust or stive caused in the process of grinding through suitable porous fabrics, by which the flour is filtered from the air, as also described in the specification. The plaintiff also claimed a combination of the three things previously claimed. In support of the plaintiff's claim the plaintiff and other scientific persons were called to speak to the novelty and utility of the plaintiff's invention; and also another important class of witnesses were called—viz., persons employed in mills and in the government dockyards, who deposed that they had never seen any machinery in use like the plaintiff's previously to the patent.

For the defence similar testimony was called, and as many as seven mills were instanced in which the process patented by the plaintiff was alleged to have been anticipated. It was said that the invention had been anticipated both in France and England.

Mr. Grove, Q.C., Mr. Garth, Q.C., Mr. T. Aston, and Mr. J. C. Mathew were counsel for the plaintiff; Mr. Brett, Q.C. (the Solicitor General), Mr. Webster, Q C., Mr. Quain, Q.C., Mr. Fullarton, and Mr. Laing were counsel for the defendant.

The learned judge left it to the jury to say whether the three claims of the plaintiff in his patent, or any and which of them, had been anticipated, and he directed them that if they found that any one of the claims had been anticipated that would avoid the patent, but as to the claim for the combination that might be good, although the elements were not new, provided the combination itself was novel. The learned judge told the jury that the utility of the plaintiff's patent was only material so far as it reflected any light on the novelty of the invention, and he cautioned the jury not to mistake mere experiments or unsuccessful attempts to attain the object accomplished by the plaintiff's patent for practical anticipations of the plaintiff's invention. The learned judge then went through the main features of the evidence for the defendant as regarded the user in different mills previous to the plaintiff's patent, and of the different written documents in which it was said that the plaintiff's invention had been anticipated, and concluded a luminous and condensed summing up of the case in two hours and a half.

The jury retired to consider their verdict at half-past four. Shortly before six the jury returned into court with a verdict for the plaintiff on all the questions left to them.

CORRESPONDENCE.

☞ We do not hold ourselves responsible for the views or statements of Correspondents.

(To the Editor of the Practical Mechanic's Journal.)

Sir,—May I trouble you to let me know through the medium of your next impression, if there has been any alteration made recently in the Admiralty tests for ship plates. As there appears to be a wide-spread ignorance as to what these tests are, you would, I think, confer a favour on your readers by letting them know through the medium of your Journal.—Yours, &c.,

Z.

Newcastle-on-Tyne,
February 6, 1867.

[In reply to Z.'s suggestion we think he is right in calling for a public statement as to the Admiralty tests, for similar inquiries frequently reach us: the tests are these.

Plate Iron (First-class).

B.B.

Tensile strain per square inch { Lengthways, ... 22 tons. Crossways, ... 18 "

Forge Test (Hot).

All plates of the first class of 1 inch in thickness and under, should be of such ductility as to admit of bending hot, without fracture, to the following angles:—

Lengthways of the grain, ... 125 degrees.
Across, ... 90 "

Forge Test (Cold).

All plates of the first class should admit of bending cold without fracture, as follows:—

With the Grain.

1 inch and $\frac{15}{16}$ of an inch in thickness to an angle of 15 degrees.
$\frac{7}{8}$ " $\frac{13}{16}$ " " 20 "
$\frac{3}{4}$ " $\frac{11}{16}$ " " 25 "
$\frac{5}{8}$, $\frac{9}{16}$ inch and $\frac{1}{2}$ an inch in thickness to an angle of 35 degrees.
$\frac{7}{16}$ " $\frac{3}{8}$ " " 50 "
$\frac{5}{16}$ " $\frac{1}{4}$ " " 70 "
$\frac{3}{16}$ " under " " 90 "

Across the Grain.

1 inch, $\frac{15}{16}$, $\frac{7}{8}$, and $\frac{13}{16}$ of an inch in thickness to an angle of 5 degrees.
$\frac{3}{4}$ and $\frac{11}{16}$ " " 10 "
$\frac{5}{8}$, $\frac{9}{16}$, and $\frac{1}{2}$ " " 15 "
$\frac{7}{16}$ " $\frac{3}{8}$ " " 20 "
$\frac{5}{16}$ " $\frac{1}{4}$ " " 30 "
$\frac{3}{16}$ " under " " 40 "

Plate Iron (Second-class).

B.

Tensile strain per square inch { Lengthways, ... 20 tons. Crossways, ... 17 "

Forge Test (Hot).

All plates of the second class, of 1 inch in thickness and under, should be of such ductility as to admit of bending hot, without fracture, to the following angles:—

Lengthways of the grain, ... 90 degrees.
Across, ... 60 "

Forge Test (Cold).

All plates of the second class should admit of bending cold, without fracture, as follows:—

With the Grain.

1 inch and $\frac{15}{16}$ of an inch in thickness to an angle of 10 degrees.
$\frac{7}{8}$ " $\frac{13}{16}$ " " 15 "
$\frac{3}{4}$ " $\frac{11}{16}$ " " 20 "
$\frac{5}{8}$, $\frac{9}{16}$ " $\frac{1}{2}$ " " 30 "
$\frac{7}{16}$ " $\frac{3}{8}$ " " 45 "
$\frac{5}{16}$ " $\frac{1}{4}$ " " 55 "
$\frac{3}{16}$ " under " " 75 "

Across the Grain.

$\frac{3}{4}$ inch and $\frac{11}{16}$ of an inch in thickness to an angle of 5 degrees.
$\frac{5}{8}$, $\frac{9}{16}$ " $\frac{1}{2}$ " " 10 "
$\frac{7}{16}$ " $\frac{3}{8}$ " " 15 "
$\frac{5}{16}$ " $\frac{1}{4}$ " " 20 "
$\frac{3}{16}$ " under " " 30 "

Plates both hot and cold should be tested on a cast-iron slab, having a fair surface, with an edge at right angles, the corner being rounded off with a radius of half an inch.

The portion of plate tested, for both hot and cold tests, is to be 4 feet in length across the grain, and the full width of the plate with the grain.

The plate should be bent at a distance of from 3 to 6 inches from the edge.

All plates to be free from lamination and injurious surface defects.

One plate to be taken indiscriminately for testing from every thickness of plate sent in per invoice, provided they do not exceed fifty in number. If above that number, one for every additional fifty, or portion of fifty.]

OBITUARY.

Sir David Brewster died on Monday, the 10th ult., at his country seat of Allerly, near Melrose, at the age of 86 years. His father was rector of the grammar school of Jedburgh, where Sir David was born, on the 11th of December, 1781. Mr. Brewster intended his four sons for the ministry; and three out of four rose high in that profession. The second son, David, chose the study of natural science and philosophy. In 1800 the University of Edinburgh conferred on him the honorary degree of M.A., and here he had the advantage of intercourse with Robinson, Playfair, and Dugald Stewart, who were then professors. In 1807 he received the degree of LL.D. from the University of Aberdeen, and in the following year he was elected a fellow of the Royal Society of Edinburgh; and in that year, also, he projected and began that most laborious work, the "Edinburgh Encyclopædia," of which he continued editor until its completion, in 1830. In 1813 he published some results of his optical studies, in the "Treatise on New Philosophical Instruments," a work which had reference to illumination generally and lighthouses in particular. He also contributed a paper to the Royal Society of London, "On some Properties of Light." The Copley Medal was awarded to him by the society, in 1815, for his paper on the "Polarization of Light by Reflection," and he was also elected a fellow. It was in 1816 that Sir David made his name popularly known as the inventor of the kaleidoscope. In 1818 the Rumford medal was given to him by the Royal Society, for further "Discoveries relating to the Polarization of Light." In 1819, in conjunction with Professor Jameson, he started the *Edinburgh Philosophical Journal*, which he afterwards carried on alone, under the title of the *Edinburgh Journal of Science*, of which sixteen volumes were published, containing many

scientific papers from his own pen. He twice had the honour of receiving the Keith medals from the Royal Society of Edinburgh, of which body he was for many years vice-president. In 1825 he was elected a corresponding member of the Institute of France, and in 1849 he succeeded the illustrious Berzelius as one of its Associates. In 1827 he published his "Account of a New System of Illumination for Light-houses;" and although he offered his services to the lighthouse boards of the United Kingdom, nothing appears to have been done until 1833, when experiments were made in Scotland, which showed that one polyzonal lens, with an argand burner of four concentric circles, gave a light equal to nine parabolic reflectors, each carrying a single argand burner. The great improvement that has been made in lighthouse illumination dates from that period; but as chief among those who made these advances we must not forget the name of Alan Stevenson. In 1830 William IV. conferred upon Brewster the honour of the Guelphic Order, and he was knighted in the following year. The last thirty-five years of his life he spent as principal of the United College of St. Leonard's and St. Salvator at St. Andrews. In 1859 he was chosen principal and vice-chancellor of Edinburgh University. He was also a magistrate for the county of Roxburgh. His favourite subject was optics in its higher and mathematical departments. It was he who, from his examinations of the solar spectrum, overthrew the assumption that white light is composed of seven colours, and demonstrated that, in reality, it was produced by the combinations of only three. Among the many branches of this intricate science which engaged his attention we may specially mention the optics of crystals, upon which he gave science many valuable memoirs, and atmospheric polarization, a subject upon which he wrote in the Edinburgh Philosophical Transactions a few months before his death. The discovery of the principle of the stereoscope is due to Wheatstone, but Sir David has the fullest right to the claim, that in his hand—chiefly through the skilful application of semi-lenses—it started into a practical instrument. To his optical researches are due great improvements in our modern microscopes and telescopes; and to his early appreciation of the labours of Fresnel this country is partly indebted for the introduction into our lighthouses of the dioptric system of illumination and of the polyzonal lens. Among his works may be mentioned his treatise on "New Philosophical Instruments," on "Optics," on the "Kaleidoscope," the "Stereoscope," his "Life of Newton," the "Martyrs of Science," his treatise on "Natural Magic," and his "More Worlds than One." The latter work was written to oppose the speculations advanced by the late Master of Trinity College, Cambridge, in his "Plurality of Worlds." He was twice married, first in 1810, to Juliet, second daughter of the late James Macpherson, Esq., M.P., of Belleville; and secondly, in 1857, to Jane Kirk, second daughter of the late Thomas Purnell, Esq., of Scarborough. By the former he has left issue David Edward, a lieutenant-colonel in the Indian Army, who was born in 1815.—*Society of Arts Journal.*

REVIEWS OF NEW BOOKS.

Long Span Railway Bridges, with Comparative Advantages of Different Types, &c. By B. Baker. 1 vol. small 8vo. Spon. 1867.

This little work professes to compare, both theoretically and practically, the advantages and disadvantages which appertain to iron bridges of spans upwards of 300 feet clear, upon the following types, viz.:—

1. Box-plate girders (tubular bridges).
2. Lattice do. (Warren truss).
3. Bowstring do. (Saltash type).
4. Straight links and boom (Bollman truss).
5. Cantilever lattice, parallel depth.
6. The same, varying the economic depth.
7. Continuous do. do.
8. Arched ribs, with braced spandrils.
9. Suspension, with lattice stiffening.
10. Suspended girders.
11. Straight link suspension.

These, the author says, constitute all the possible types of bridge structure which are not absolute eccentricities. In this, at the very outset, we cannot agree; for one important type, which in no sense can be called an eccentricity, except that it departs widely from previously much employed ones, viz., that of Herr von Rüppert, of Vienna, as shown at the late Paris Exhibition, is not even alluded to. Viewed in the modest light in which the author proposes himself to regard his work, viz., as a mere cartoon, an outline sketch of some of the questions upon the decision of which any just comparison of different systems of girder bridges fitted for very long spans should be made, we are willing to accept these papers, reprinted from the pages of a technical newspaper, as evincing some mathematical ingenuity in method, and a considerable acquaintance with the subject treated of.

A good many of the conclusions arrived at appear to us, however, unsound, and these to the man who must accept upon faith the way they profess to have been got at, and who will be prone to take symbols as indications of a safe pillow to repose upon, would be very likely to find they led him instead into very ugly difficulties.

The mathematical reasoning of the work is, in fact, mainly employed for the purposes of finding the proportionate weights for equal spans 300 feet or upwards, and the limiting span on certain assumptions, *i.e.*, when the structure will only carry itself. The relative other advantages or disadvantages are almost altogether uttered in words, and in a very brief, insufficient, and, as it seems to us, in some cases erroneous form of assertion only by the author. The work is thus unsatisfactory, because with the aspect and profession of being a rigid mathematical investigation, it in reality is not one, in the full sense in which such could alone here form any safe light or guide. This is so, albeit that we are perfectly ready to admit that extreme generality and the involvement of many minute conditions as affecting the mathematical investigation of practical questions such as this are best avoided, so far as the reality and comprehensiveness of investigation will admit.

Had mathematical expressions been employed throughout, the author himself would have been preserved from some of the unsound conclusions which he has so very confidently enunciated. For example—we can only spare space for one—in the discussion at the Institute of Civil Engineers upon a paper on certain American bridges, in which the straight-linked girder, our author's Type 4, was extolled, the nearly universal opinion of the members who joined in the discussion was opposed to that construction, upon this amongst other grounds, that where the angle made with the horizontal boom by the diagonal tye bars becomes very small, as it does where these are long and reach to the centre of the span, these diagonals oppose little or no resistance to the deflection of the boom or platform; because, while the latter descends *quam prox.* vertically, the attached ends of the diagonal tyes, which are free to descend in a circular arc described round the fixed centres of the bar above the piers, move within the limits of the deflection in a curve which scarcely differs from a vertical right line, and hence get no strain visited upon them, and so give no support to the platform. This conclusion, Mr. Baker says (p. 26), "is palpably false," and he attempts to prove that it is so by a paragraph, the argument, if any, contained in which we must confess ourselves wholly unable to follow. We venture to affirm that everything that is there said upon this point is "palpably wrong," and that the author has lost sight altogether of the effect of the enormous *length* of these diagonals in reducing the strain per unit of section, and the effect of this when resolved from the line of the tye into the vertical. This will be quite the same in result whether there be one diagonal and the boom only, considered, or two diagonals opposite each other, connected at the centre point to one another and to the boom.

In fact, the writer of this notice can appeal to his own practice as proving the very fact here denied to have any existence. In a swing bridge of above 60 feet span, executed from his designs, to pass railway trains, it was found that the outer diagonal tyes connected to the extremity of the boom, here a box girder of about 3 feet deep, at about 63 feet from the pier, which was some 10 or 12 feet in height above the top of the box girders, gave no support whatever to the platform; and these and the other diagonals were only made to give the required support by providing adjustments, by which they were strung up, with initial tensions upon each, in amount a function of the angle of each with the horizon, &c.: and this not only proves that the fact is so, but it involves, as might be seen were we to pursue the subject, some grave practical after difficulties.

The author, however, goes on to point out another class of evils incident to and inseparable from this class of bridge, in which he states what is quite correct, and this difficulty he admits can only be attempted to be surmounted "by the insertion of bracing, as is sometimes done in the American bridges (of this type), when there will be little hope of

obtaining an economical structure." He proceeds most *naively*, however, to say, "Having pointed out this difficulty, *we shall assume it to be surmounted* without producing any abnormal strain on the boom, or any extra provision of bracing;" and then he goes on to prove to his own satisfaction here and subsequently in the work, that this form of straight-linked girder bridge is the most economical of all the types, whatever theory may please to say to the contrary.

"All our types as yet have occupied precisely reverse positions in the scale of economy to that indicated for them respectively by theory; we may not, therefore, be surprised if we find this (the straight-link girder), the lowest in the scale, positively heading its competitors." Such a result, we confess, would make us very suspicious of any theory; and we must say that it looks here very like as if the theory was fitted in with a foregone conclusion. We feel quite assured that the practical opinion held by the members of the Institution of Civil Engineers as to those American straight-link girder bridges, viz., that they are neither structurally safe or advantageous nor in material economical, is that which is true, and not the reverse, as asserted by Mr. Baker. The analogies between this straight-link girder and the bowstring bridge, as given in p. 24-25, appear to us also perfectly unsound.

For a writer whose first line starts with the words, "according to Dr. Johnson," there are some odd bits of composition here found. "In the present *progressed* state of the art of building," may be American, but it certainly is not English. "Starting with the load and determining the strain on *that data*" seems objectionable; to be "almost identical in general and outline proportions," is less clear than pleonastic; but these are small blemishes and perfectly forgivable even here, though far more so were the work less full of assertions, and more really what its title-page professes—an investigation of the comparative theoretical and practical advantages of the various adopted or proposed type systems of construction. The investigations are partial and incomplete, the comparisons in a practical sense, in our judgment, in many respects erroneous, and the whole of the practically possible and valuable type systems have not been examined. As articles in a technical journal, these papers had merit enough to have been read without much criticism: they were scarcely worth republication, but now when collected in book form must submit to more rigid examination.

Rain: How, When, Where, and Why it is Measured. By G. J. Symons, F.M.S., &c. Small 8vo. Stanford, London. 1867.

There is no man who devotes himself heartily, and undaunted by laborious work, to a single object of scientific and of practical value, as the author of this little work has done to that of British rain-fall, but deserves all possible encouragement; and whatever he produces of the literature of his subject should be viewed, if not with favour, at least with gentleness and indulgence.

In this little volume of only between 80 and 90 pages Mr. Symons proposes an exact but popular setting forth of his subject, its aims, objects, and remoter uses and ends. All this is done, and clearly enough, but we cannot avoid saying that we think the author could have done it better. As it stands, the reader ignorant beforehand of the *principles* of meteorology will find the book very unsatisfying, if not unsatisfactory. He will learn a good deal about rain gauges and keeping them, and something of the facts they have elicited; but he will fail to be made any wiser as to what *is* rain, how it is produced, what are the great cosmical conditions on which its larger or its smaller distribution in time, place, and quantity depend. This want is in some places very decisive; for example, the question is asked and answered as to some *facts*—Will a rain gauge catch more on the roof of a house or at the level of the ground? but not a word of explanation is given as to the facts stated, nor, in fact, on this rather curious point are the *whole* of the *facts* given, or even hinted at. There is no doubt but that lofty and large buildings, such as Westminster Abbey and York Minster, on both of which experiments have been made, do exercise a large influence upon the closely-adjacent rain-fall at base and summit, quite independently of the mere question of elevation. One of the uses of cathedral towers, even in the minds of their builders, if we may be excused the pun, was to "raise the wind." In that original sense their powers are not extinct, but also in a literal sense they produce great aerial movements in their neighbourhood by the obstruction they present to the horizontal air currents; and these, when charged with humidity, discharge their load of rain *very differently* at different times, according to the direction with which the wind impinges on them, its force, and so on. Any one who in a gentle rain passes along Victoria Street, past the western towers of Westminster Abbey, may be certain, in certain states of the wind, to get ample satisfaction as to the truth of this; for he may get thoroughly drenched as he passes just to the north-west of the towers, in rain which would not be worth an umbrella anywhere about the neighbourhood at the same moment.

Mr. Symons has produced a useful little book, but we think he might make it one much more useful, as well as interesting, if in his next edition he doubled its size, and gave a clear succinct account of such principles of meteorology as relate to rain-fall.

Lehrbuch der rationellen Praxis der Landwirthschaftlichen Gewerbe, fur Chemischer, Landwirthe, Fabrikanten, Architekten, Ingenieure, und Steuerbeamte. Von Dr. Fr. J. Otto, &c., &c. In zwei Bänden. Braunschweig. 1867.

The second part of this careful and full work on the scientific practice of manufactures dependent directly on agriculture, has appeared, and is devoted wholly to the manufacture of beetroot sugar, which is treated of with that honesty and thoroughness which is so characteristically German. The woodcuts intercalated in the text, executed with much of the beauty which German and French wood engravers of apparatus and technical objects have attained, are chosen from the very best and most recent examples of appliances employed in the beetroot sugar manufacture, including the "Fabrik" or manufactory itself, in its complete and orderly arrangement.

It is a wonderful thing to what vast proportions this beetroot sugar trade has grown since the days—not more than seventy years since—when Chaptal and others of the great chemists of France gave it birth, under the auspices and insight of Napoleon I., as one element in his ill-starred "continental system." And it is remarkable also, and ought to be a lesson to those amongst us who at the present hour prefer a moment's falsely won and hollow popularity, fished for by underrating the general technical progress of foreign nations and equally overrating our own, to look back into the current literature of that period, and see the lofty disdain with which Englishmen generally regarded "the insane attempt of the Corsican tyrant to squeeze sugar out of beetroot and carrots," and how they boldly predicted that such "humbug of the French apothecaries" could never come to anything but loss, nor ever interfere with the manufacture of cane sugar. We shall not attempt statistics here, but we all know something of the dimensions of this trade now, and what a *cordon* of ancillary manufactures it has gathered around it, with and during its own growth.

This part of Professor Otto's work is not to us in Great Britain of the same amount of practical interest that it is to Germans and Frenchmen, &c., for we have no beetroot sugar manufacture rooted amongst us, nor are we likely to have. The prime condition of its success in any country consists in such conditions in the tenure of the soil and in its agronomic qualities, in the price of labour, and in the climatic conditions of seasons, &c., as shall *insure* in all average years an abundant and unfailing supply of beetroot or mangel, and containing a maximum of sugar-making material.

These conditions are to be found united in many parts of the European continent, but nowhere in our own islands. In England land is made too valuable (perhaps we ought rather to say too dear, for they are by no means identical) by landlordism, clericy, and wasted taxation, for any such manufacture to succeed, even with the wages of the farm labourer at the splendid rate of eight or nine shillings a week, as it is kept ground down to, in so many of our agricultural counties. In Scotland suitable land for the crop is too scarce not to be too dear, and the coldness of the climate gives a root less rich than desirable. Ireland might have been thought the one division of the British Islands in which the conditions needed might have been found more or less completely fulfilled. Beetroot sugar manufacture was tried there some nine years ago, and proved itself a disastrous failure. It is quite true the actual failure, as it occurred, was due to that ignorance of technological and manufacturing laws, and want of foresight as to all collaterals, that characterize most Irish enterprises. But in the actual conditions under which the land of Ireland is rented and tilled, it might have been predicted that ultimate success was not possible, even were we to put out of view the fact that the Irish capricious climate has too little sun and too much moisture, to produce a root of

maximum sugar richness under any circumstances. The true use of the magnificently large and healthy root crops which Ireland produces is not for making sugar, but for making their natural juices through the digestive and assimilative powers of the stomachs of cattle, into fat and lean. For this two or three per cent. of sugar in relation to the watery parts of the root, less or more, is not of paramount importance: it is far otherwise in the sugar manufacture.

It would be out of place in a mere review, to go at any length into the somewhat complicated conditions, social, fiscal, agricultural, climatic, &c., &c., which *insure* to the continental beet sugar manufacturer a sufficient and unfailing supply of his raw material of the best quality; or to show how he is so circumstanced as to be able to make the best of his waste educts—those which in Ireland proved, in great part, waste indeed.

There are, however, some parts of our colonial empire which may hereafter probably become great seats of beetroot sugar manufacture. Amongst these are Queensland and other parts of Southern Australia, and probably New Zealand; but nowhere, even for these colonies, is it a manufacture to take root there in our days. Dr. Otto, the author of this work, is also author of the article on beer brewing, the distillation of brandy, and the manufacture of spirituous liquors, in another very valuable work, viz., "The Handbook of Technical Chemistry," edited by Dr. P. Bolley, professor of technical chemistry at Zurich, which has now reached its eighth part, and comprises therein fourteen very excellent articles on as many great subjects of chemistry applied in manufactures.—Ed.

SHORT NOTICES.

Ueber Landwirthschaftliche Feuerschere Tiefbauten. Ein Vortrag von E. H. Hoffmann, Kreisbaumeister, &c. 1 thin vol. 4to, with five copperplates. Wiegand & Hempel, Berlin. 1867.

This small work is a report addressed by Herr Hoffmann, who is Kreisbaumeister, or as we should say, chief provincial architect to one of the circles of Prussia, addressed to the Agricultural Club of that kingdom. His object is to point out the general and detailed construction for homesteads or farm buildings, fitted for Northern Germany, of the best character for at once facilitating to the utmost, economy in labour, and time of management, and efficiency of supervision, with comfort, &c., to the indwellers both human and bestial. To this he has added methods of construction intended to render all the important parts of the farm steadings—viz., all those which contain the farm stock, dead or alive—fireproof, or at least, as the word more exactly means, fire-secure. The designs, which are given in five large folded copperplates with explanations, have much merit in various ways; but are designed for a far more rigorous climate than ours, and for a very different state of husbandry; and, moreover, for a very different class of cultivators generally, than any which in the range of tenants exist in Great Britain. It is a work, not so much of direct practical value to the British agricultural architect, as one of curiosity to him, and withal one capable of conveying many useful hints. The report itself, which only consists of about forty octavo pages, is a clear well-written argument. By the aid of several wood-cuts in the text, Herr Hoffmann illustrates the greater or less advantages of the various collocations of *separate* blocks of farm buildings which constitute the more common and, as he deems it, the less advantageous arrangements. Ventilation is scarcely a German virtue, at least in winter, and the only thing that strikes us as being perhaps but scantily provided for in some of these designs, for what may be called centralized manufactories of human food.

On the Relief of London Street Traffic, &c. By Peter W. Barlow, C.E., F.R.S. Pamphlet. Spon. 1867.

This in reality embraces two projects, the one for a tunnel for omnibus and like traffic, with lifts at either end to be placed below London Bridge, and crossing beneath the Thames; the other for working this and other like tunnels under some of the great lines of street traffic by means of alternate inclined planes, down one of which the traffic is to run, in order that it may run of itself up part of the other. So far as the former project goes, there can be no doubt of the importance of securing a passage for traffic across the river below London Bridge; though we should greatly prefer a broad, high-level bridge placed below the Tower to any feeble means like this to pass the enormous flood of heavy and light traffic that now has to pass by water or over London or Southwark bridges. As to the latter, these inclined planes are nothing more than a *rechauffement* of the old scheme of the *undulating railway*, brought forward about the year of grace 1830, and of which much may be found in the venerable pages of the earlier volumes of the *Mechanic's Magazine*. We may add, that the mechanical investigation of this up and down railway, appended by Lieutenant J. C. Adagh, R.E., contains just the same sort of fallacies that puzzled the ordinary world at the more ancient epoch of this plan. We should be very glad if the author would make good for us Dr. Desagulier's dictum, which he relies upon, and *produce to us* a man to turn a winch, with a continuous average pressure of 30 pounds, through 3½ feet per second for 10 hours per day. If he will do so, we will undertake to get the man double British labourer's wages, if he will covenant to stick to his work.

The Purification and Utilization of Sewage, with Plans of the Croydon Irrigation Fields. By B. Latham, Esq. Spon. 1867.

This pamphlet does not profess, in its author's words, to be more than "explanatory of what has been done for effecting the purity of our rivers, and the mode of applying sewage in a liquid form to land." It is clearly written, but leaves a good deal untreated of, and seems to us to travel over the usual and beaten fallacies as to the unit value of sewage. How is it possible, in common sense, to fix an arbitrary value of 2*d.*, or of ¼*d.* per ton, or of 8*s.* 4*d.* per head as the value of sewage, when it has been again and again shown, and is even here admitted, that the value is dependent upon local and other circumstances, and that there are circumstances in which it can have no value at all. It is very amusing to see how the sewage doctors disagree about this fundamental article of belief, from Liebig and Hoffmann's 1·84*d.* and 2*d.* per ton, to Mr. Morton's 3 farthings, and Professor Voelcker's "theoretic 2*d.*, which in some instances would be altogether lost," and become = 0; whilst Sir Charles Fox, who is never outdone in evidence of exactness, &c., takes a more decided tone, and declares upon his veracity that the value of sewage is *precisely* one penny and three farthings per ton, and neither more nor less. "In mediis tutissimus ibis." One would think that sewage was *always* the same definite chemical compound, and of exactly the same concentration, whether the people were fed on "white clay," or rice, or birch bark, or on beef, and whether they were abundantly supplied with water, or as thirsty as Bedouins.

Precis de Chimie Industrielle, &c. Par A. Payen, Memb. de l'Institut, &c. Fifth Edition. 2 vols., with atlas of plates. Hachette, Paris. 1867.

This is a work on technical chemistry, to which we have nothing in English to compare. Nothing at once so brief, so perfect, so replete in its information, and so full of recent improvements in knowledge and methods.

Like many other special chemical works by French authors, it is a system of chemistry, keeping always in view the technical applications and ends of the science. There are admirable articles on caoutchouc and gutta-percha, sulphuric acid, refining gold and silver, the manufacture of sodium and aluminum, iodine and boracic acid, and others even more complete, because the author gave himself rather more space, on limes, cements, plaster. These lead naturally to glass manufacture; and the first volume ends with the making of white lead, and what is much less known in this country, the production of zinc white.

We have not yet received the second volume.

L'Hydraulique. Par E. Marzy.

Here is a little hydraulic work of a different stamp. One of those nice little octavo volumes of popular scientific knowledge, constituting part of the "Bibliothèque des Merveilles," published by Hachette & Co., Paris, illustrated by some sixty charming woodcuts.

It is a sharply cut, sparkling account of the chief points of popular interest relating to springs, wells, rivers, canals, &c., in their natural or cosmical, and in their artificial or applied relations. Any engineer or mechanician will find it delightful reading for an hour of rest and enjoyment.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

INSTITUTION OF ENGINEERS IN SCOTLAND.

ON CERTAIN POINTS IN THE MANUFACTURE OF MALLEABLE IRON, WITH SPECIAL REFERENCE TO THE RICHARDSON PROCESS.

By St. John Vincent Day, C.E., F.R.S.S.A., &c.

January 15, 1868.—Since the year 1784, when Cort introduced the process of puddling, there has not been any really great advance made in improving the general results obtainable from the conversion of crude or pig into malleable iron in the puddling furnace until very recently.

By no means do I here intend to arrogate for Cort the raising of the puddling process to its present state of comparative efficiency, for no matter how very imperfect that process yet remains, still it is well known that the results produced by it were not generally to be depended upon until long after the inventor's unfortunate career terminated with his death—indeed, the first quarter of the present century had nearly passed away ere the puddler's manipulations could be relied upon continuously; and it is highly probable that even then the uncertainties of production would not have been largely removed but for the careful attention of some of the English iron-masters, who perceived a wide field opening up for a high class of manufactured material in the iron canal and river boats, and railways, then coming into vogue, and, later still, in supplying that required for our great tubular and girder bridges and lines of trans-oceanic steamships.

During the present century, however, innumerable attempts at improving the process have been made at home, on the Continent, and in America, still with no good effect generally; indeed, the value of what has been done, taken on a broad, practical, and therefore commercial basis, has been extremely small. It is, however, perfectly true that the failures which have been encountered have increased our stock of information as to the peculiarities, or rather specialities, of the compound we have been treating in the puddling furnace, and in this particular view recorded failures, when accompanied by a faithful declaration of what took place, are of the highest importance. As a very striking instance, I may allude to the most recent and gigantic failure that has, and probably ever will occur in a future time in the metallurgy of iron—I allude to the impossibility of making good commercial iron out of the ordinary ores of this country by the Bessemer process. Mr. Bessemer has himself on several occasions openly confessed that he could not succeed in making good malleable iron by his process, purely on account of the impossibility of removing sulphur, but more particularly phosphorus, in the converter; his early experiments showed distinctly that whilst the highly oxidizing effect of the blast injected into the converter was most efficient in removing carbon and silicon and some of the lesser impurities, still the phosphorus and sulphur remained untouched; the immediate consequence of which has been that his process has never come into practice *for making iron from the ordinary run of British ores*, by far the larger portion of which contain notable quantities of these two elements, of which phosphorus is the greater enemy, its presence rendering the iron *cold-short*, whilst sulphur has the opposite effect of rendering it *red-short*.

I have before referred to Cort's process, and prior to directing attention to the more immediate subject of this paper it will be an advantage, in a casual way, to refresh our memories by considering what has been done successfully towards the improvement of puddling since his day up to the present time. Before doing so, however, I wish to remark that, although the invention of puddling is usually ascribed to Cort, there exist very grave reasons for withdrawing from him the origination of it, as a reference to the specification of a patent granted to Thomas and George Cranage in 1766 will easily show.

The Messrs. Cranage were workmen employed at Colebrookdale; and it is recorded that puddling was practised there prior to Cort's invention, for when the latter applied to Mr. Reynolds, at that time the manager of the works, he replied in his Quaker tongue, "If thou wilt come with me to the works, I will soon show thee the thing done." Cort went, and at the command of Reynolds, Tom Cranage made a puddled ball in their presence. It appears, however, that the process was not carried out on a large scale at Colebrookdale until after Cort had been there, so that it is probable some practical difficulty existed in what the Brothers Cranage had done. This fact would show that to Cort must unquestionably be attributed the high distinction of being the perfecter rather than the inventor of the process called "puddling."

The process of puddling, too, was very completely set forth in the specification of Peter Onions in May, 1783, about a year prior to the date of Cort's patent; indeed, it appears extremely probable that iron-masters at that period, hearing of the partial success of the Cranage process, had begun to set themselves the task of perfecting it: hence the inventions of Onions and Cort so close one upon the other. The question of Cort's invention has, however, been so frequently discussed elsewhere that I need not further allude to it here; the deplorable tale connected with it is so well known to us all that it need not be again enlarged upon.

The next great step of improvement that presented itself was that of Mr. Samuel Baldwyn Rogers, of Nant-y-Glo, who substituted the "iron bottom" for Cort's sand bottom. This, like every other really valuable discovery, was condemned by the Welsh iron-masters, and after it had been derided at by Mr. Hall, of the Rhymney Ironworks, Mr. Hill, of the Plymouth Ironworks, Mr. Homfray, of Tredegar, Mr. Crawshay, of Cyfartha, Mr. Forman, of Pendarren, and others, it was ultimately tried at Ebbw Vale by Mr. Richard Harford, who on discovering the advantages about or shortly after the year 1818, adopted it, since which time others followed his course until wherever puddling is now practised the cast-iron bottoms are used.

Rogers' fate as an inventor was as sad as his unfortunate predecessor Cort; both lived for years, and ultimately died, in absolute penury.

The "boiling process" was the next great stride: it is generally attributed to Mr. Joseph Hall, of the Bloomfield Ironworks.

"Boiling" is produced by charging certain oxidized compounds of iron on the puddling hearth, from which, as soon as melted, some of the oxygen begins to separate, and, uniting with some of the carbon of the iron, forms carbonic oxide, the presence of which may always be detected by the well-known bubbling about of the metal, attended with endless escaping jets of blue flame. Until the charge is melted the solid oxide is covered with liquid cinder, composed in great part of protoxide of iron: this being combined with silica, constitutes a silicate of protoxide of iron, which, after melting, combines with additional silicon in the pig and some of the iron of the charge, forming the tribasic silicate of protoxide of iron ($3\,Fe\,O, Si\,O^3$), without the presence of which the process of puddling could not be carried on, this silicate possessing the peculiar property of not further oxidizing iron at the most exalted temperatures employed, and being easily separated from it, so that although the granules of iron in the puddling furnace after the boiling stage is over and the temperature of the furnace is lowered, are lying scattered about in it, still, on being pressed together they unite, the fluid silicate being easily squeezed out from between the surfaces of contact by means of the puddlers' balling rod, whilst that portion which still clings to the iron after the balling is over is what we see extracted from the mass under the shingling hammer and between the roughing rolls. Boiling, then, along with the use of roasted tap cinder, or "bull-dog," as it is generally termed, constitutes the last great step in the chemistry of the process since the time of Cort.

In the mechanical operations of puddling and in the construction of the furnace several attempts towards improvement have been and continue to be made. In the furnace itself the use of water-troughs through the bridge, and in some cases forming the sides of the puddling hearth, have come into practice; but their value in a sense of effecting ultimate economy, for several reasons, appears to me to be very questionable. Double furnaces, too, have been tried—that is to say, furnaces capable of containing a double charge of metal, and with a puddler working at both sides; but it is a striking fact that they are being given up, and the old-fashioned single furnace still obtains. I am informed by some of the Scotch iron-masters, that the iron from the double furnace is never so good as from the single furnace, and the charge is generally longer in melting. The chief object intended by their introduction was a diminution in the fuel consumed per weight of iron manufactured; this to some extent is obtained, and probably herein consists the reason why the charge is longer in melting. Considerably less than twice the weight of fuel has to melt exactly twice the weight of iron; but the furnace is not twice as large, generally not more than 10 or 11 inches, or less than a foot, broader than a single furnace, the height and length being the same, so that the space occupied by the heat from the fuel in the double is nearly proportional to that of a single furnace: but as the charge of iron therein is proportionately very much greater than the fuel, it follows that a longer time of melting should obtain: at least, the question having been submitted to me for consideration, this is the only reasonable view I have been able to arrive at. As to the quality of the iron produced in double puddling furnaces being frequently inferior and of indifferent nature, I cannot account for that in any other way than by looking at the cause as inherent in the difficulty of getting the two puddlers to work the two portions of the charge in concert with each other; it is almost certain that one will work his part of the charge more or less than the other, thus producing iron in the same furnace necessarily of dissimilar quality. However, the cause of inferiority of double puddling furnaces against single is a question by no means thoroughly investigated, and it forms a topic which I think this Institution might discuss with obviously great advantage. It is probable that when a perfect system of mechanical puddling is devised, that then, provided such is effected by the movement of rabbles, double furnaces may be generally adopted, as certainty of similar action of the two instruments may then be insured by their being placed under the control of properly arranged machinery.

Speaking of mechanical puddling, numerous expedients have been tried, but with no practical success generally, in Great Britain. At Dowlais almost every hitherto conceivable means for doing away with the puddler has been resorted to, but with what result? I have no doubt that many of the members of this Institution will remember the singular paper read by Mr. Menelaus to the Institution of Mechanical Engineers, who met at Paris during the past summer—a paper, I say, singular, because it was so very dissimilar to what papers read before such institutions usually are; we generally and naturally find ourselves and others recounting our and their successes, but here Mr. Menelaus in the most laudable manner has placed on record everything that has been done at those gigantic works under his control, all of which has ended in failure, and he has not attempted to hide the failures either.

At Dowlais, too, Mr. Anthony Bessemer's revolving puddling furnace has been used, but it has failed; as well, I believe, the injection of steam by a tube or blast-pipe, according to Mr. Nasmyth's plan; also air and steam combined after the process of Guenyveau; and, I am told, even the introduction of a blast of air alone through a blast-pipe—still all ended in absolute failure.

The most successful experiments in connection with mechanical puddling that have come under my notice were those conducted by MM. Dumeny and Lemut at the Clos-Mortier Forge, in the commune of St. Dizier (Haut Marne). I will not now take up your time in describing the various mechanical arrangements they have adopted, but merely state that I some time since received a report in which they assert the practical results of their apparatus are—1st, That the consumption of fuel is greatly reduced per ton of metal produced; 2nd, The work is accelerated and the production of the furnace increased, from which economy in the general and working expenses has resulted; 3rd, The obviating the necessity of workmen in stirring the cast iron lowers the price of labour, whilst at the same time it enables the wages of the regular puddler to be augmented, although the labour is lightened; 4th, The waste is about the same as in the system of ordinary puddling, which is equivalent to saying (in other words) that the yield is the same as under the hand system; 5th, The improvement in the quality of the iron is undoubtedly the effect of the mechanical puddler.

Having now drawn a sketch of puddling from its earliest date down to the present time, I proceed to direct your attention to some remarkable facts connected with a new process, viz., "The Richardson Process," which I am sure will be of great interest, as it is of the gravest importance to nearly every member of this Institution, being particularly interesting because the chief practice with it has taken place in the neighbourhood of Glasgow. Of this process and its results some facts have lately appeared in the engineering journals, and I am happy to be able to state that, in the views which I originally formed, my conclusions have since been fully borne out by the remarkably accordant results we have obtained at the Glasgow Ironworks, but more particularly at Parkhead Forge.

Generally, I have no doubt the members of this Institution are aware in what the "Richardson Process" consists. I will presently, in few words, explain its chief feature, but first wish to mention what has been previously attempted in a similar direction. Reuben Plant was among the first to introduce blasts of air and steam into the puddling furnace, and provided he had continued his experiments to completeness, there is little doubt but that what is now known as the "Richardson Process" would have been a nestablished mode of manufacture twenty years ago. As it is, to Mr. Richardson, who was associated with Plant at that time, the credit is due of having made the first recorded experiments of blowing air below the surface of fluid pig iron, when he obtained that peculiar series of changes which we daily see produced in the Bessemer converter. Had Mr. Richardson continued the blowing of air long enough, there is no doubt he would have succeeded in making worthless malleable iron, as Mr. Bessemer has done, through not being able to eliminate the sulphur and phosphorus. Other circumstances, as Mr. Richardson informs me, interfered, that a stop was put to the prosecution of the experiments, and thus it became reserved for Mr. Bessemer to follow up that same line of triumphant investigation by which he has immortalized his name—the process for making "Bessemer steel."

At Dowlais, in particular, as well as at Cwm-Avon Ironworks, in Glamorganshire, blasts of air were blown into the metal on the puddling hearth, but for a very different object to that which the "Richardson Process" seeks to effect. In all the experiments, as I am informed, that were made prior to Richardson's the blowing was continued for a long time after the iron had been brought to the boil. Now it is perfectly clear that in an ordinary furnace such continuous pouring in of oxygen would boil the metal to such an extent that it must run rapidly away with the slag from the stopper-hole, and being continued long after the desilicatization and decarburization of the charge were effected, would oxidize the iron to an enormous extent, thus diminishing the yield so much as to reduce the iron-masters' profits to a degree that could not be tolerated. But these are not all the defects of such a constant in-pouring of oxygen: the powerful attack upon the carbon and the silicon, and after that the combination with the iron itself, must raise the temperature of the furnace to such an extent that the bricks usually employed in the construction of such furnaces would melt away, and the life or duration of the furnace would therefore be reduced to a comparatively brief existence; and I may here remark what is a singular fact, that although persons originally engaged in such experiments did not discover a remedy for this evil, it is well known that for puddling furnaces common soft bricks are employed, the higher limit of temperature employed for puddling not requiring the use of the harder and more durable kinds which are used for furnaces wherein the temperature ranges higher. The same defect of the more rapid destruction of the roof has been met with in recent processes for making steel, but that has been entirely overcome by the use of harder bricks and a higher roof. Having now shown the general nature of previous attempts, I proceed to explain the different course of action that Mr. Richardson adopts. In place of continuous blowing the blast is introduced through a tubular rabble connected with a blast receiver immediately after the charge is melted, and continued until the metal is brought to "the boil," when it is withdrawn. The period from the melting to the boil with the iron used at Parkhead under the common method of puddling occupies from twenty-five to forty minutes; this, by the Richardson Process, is reduced to ten minutes. The temperature of the furnace being higher, the period from the commencement of the boil to that when decarburization and desilicatization are completed, and the iron separates from the slag and cinder, is again reduced. But the balling operation is of a little longer duration than under the old method, on account also of the greater temperature, the granules of iron requiring more time to cool down to that temperature at which they adhere when pressed together. The following table, No. 1, of some of the first experiments made at the Glasgow Ironworks, shows the time occupied in conducting each stage of the process, as well as the yield:—

TABLE I.—EXPERIMENTS AT THE GLASGOW IRON COMPANY'S WORKS.

Date of Experiment, and Number of Furnace.	Weight of Charge.	Charge composed of.	Time of Charging.	Iron Melted at	Blast put in at	Blast on till	First Ball out.	Last Ball out.	Time occupied from Charging until the Iron was Finished.	Yield.	Diminution of Charge.	Remarks.
30th May, 1867.	Cwts. Lbs.		H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	Cwts. Qrs. Lbs.	Cwts. Qrs. Lbs.	
Furnace No. 17, .	4 0	Pig iron exclusively.	7 0	7 27	7 28	7 36	8 4	8 8	1 8	Not ascertained.	Not ascertained.	
11th June. Furnace No. 17, .	4 0	Pig iron exclusively.	6 12	6 42	6 43	6 47	7 18	7 22	1 10	3 3 14	0 0 14	Three rabbles used to prevent any one becoming too hot.
11th June. Furnace No. 17, refettled, . .	4 0	Three cwt. pig iron and 1 cwt. refined or plate metal.	7 30	8 1	8 1·5	8 6·5	8 35	8 40	1 10	3 2 14	0 1 14	Same number of rabbles used as in the preceding experiment.
13th June. Furnace No. 17, .	4 0	Common pig of the worst quality used in the works for a long time.	6 5	6 35	6 35	6 43	7 16	7 20	1 15	3 2 7	0 1 21	Three rabbles used.
13th June. Furnace No. 17, .	4 0	Same as in the preceding experiment.	7 30	8 3	8 4	8 12	8 36	8 41	1 15	3 3 18	0 0 10	Five rabbles used.
Furnace refettled, and again charged, Means, . .	4 0		Mean time of blowing in, 6·36 minutes.						1 11	3 2 27·25	0 1 0·75	The rabbles are very little affected, and therefore will last a long time.

In these experiments the time of working a charge composed entirely of Scotch pig was brought down to one hour and eight minutes, whereas the usual time is from one hour thirty minutes to one hour forty-five minutes under the old method; the yield is considerably higher; so high, indeed, as to require only 21 cwts. 1 qr. 17 lbs. of pig iron to produce a ton of malleable iron, showing a loss on the conversion of only about 6 per cent. Then as to the purity of the iron, it is most remarkable; two samples which I sent to Dr. Stevenson Macadam of Edinburgh to be analyzed have given the following results:—

ANALYSIS.

Name of Element.	Square Bar.	Round Bar.
Iron, ...	99·569	99·648
Carbon, ...	0·035	0·031
Silicon, ...	0·076	0·075
Sulphur, ...	0·025	0·028
Phosphorus, ...	0·031	0·034
Manganese, ...	Trace.	Trace.
	99·736	99·816

We see the sulphur and phosphorus are within the merest shadow of being entirely eliminated, evidently showing that some special influence must be present when puddling iron according to Richardson's system that is not found elsewhere; iron never has been made from British ores, on a commercial scale, so pure as in these two instances. Made from inferior Scotch pig, which always contains such a very large percentage of these two elements, the extent of their elimination is all the more remarkable. But not to draw any hasty conclusions, I have prepared tables Nos. 2, 3, 4, 5, 6, 7 and 8, showing the percentages of these two elements in all the British pig irons, from the analyses published in the Blue Book "on Cast-iron experiments."

(*To be continued.*)

MONTHLY NOTES.

ERUPTION OF VESUVIUS.—Few people can form a clear idea of the eruption of a volcano, and therefore a few extracts from an interesting letter written to a friend in Paris, by a clever young painter, who won the grand prize at Rome last year, son of the learned M. Regnault, of the Institute, may be acceptable. M. Regnault and party started from Naples the other day at ten in the morning, but, in consequence of the difficulties of the ascent, only reached the source of the lava as the sun was setting. The sight he describes as sublimely horrible; the lava came boiling out of a kind of tunnel, and flowed like a torrent, but with the glare of molten metal at a white heat; at times its flow was interrupted, when the writer describes it as swelling and heaving like the breast of a huge giant, and belching forth sulphurous vapours. They stood on the site of an old crater, which last year was hollow, but which had since been heaved upwards and rent asunder, and through the fissure thus caused came jets of smoke, ashes, and projectiles; these falling around had created a second cone, which increases daily, and now crowns the summit of the grand cone; at the foot of this second crater, at a spot where the great one is still open, poured out the molten torrent, divided into two or three streams, which reunited at the foot of the cone, and then again separated into two branches, one of which flowed on towards Resina, and the other towards Torre del Greco. Over the heads of the party floated a great mass of smoke, illuminated by the red glare of the lava, and at intervals of from ten to fifteen seconds an immense black column issued from the crater and fell in ashes around. In the midst of this

column of fire and smoke were thousands of heated stones, which fell on the small cone and rolled down its sides with terrific noise. When a walking-stick was dipped into the burning lava it immediately burst into flame, like a match, and the current was so rapid that the stick was nearly carried out of the hand. The heat was so intense, that even with the hat before the face, and a handkerchief over the hand, it was impossible to support it for more than three or four seconds. From time to time the guide of the party flung a small quantity of lava out of the stream, and the party were able to produce impressions of coins which they chanced to have about them. In descending, the party found itself face to face with a new torrent of lava, which had started from a spot above that which they had visited, and was slowly descending the very route which they had left; had there been any delay in their journey, they might have been surrounded, and placed in some difficulty, but they succeeded in passing in front of the torrent. On the following day they ascertained that the new lava stream had taken the road to Torre del Greco, after having passed over a distance of more than a mile during the night.

PARIS' WAVE MEASURER.—The instrument forming the subject of this notice has been designed by Admiral Paris for measuring the height of waves—Admiral Paris being director-general of the Office of Maps and Plans in the French Navy. The instrument consists of a light wood pole, such as pine, whose inferior diameter is 6 inches and upper rather above 2 inches, which is loaded at the lower end: this pole being loaded at the lower end with 44 lbs. of sheet lead wound round it, so that when placed in the water it floats vertically, with a portion of its length above

Fig. 1.

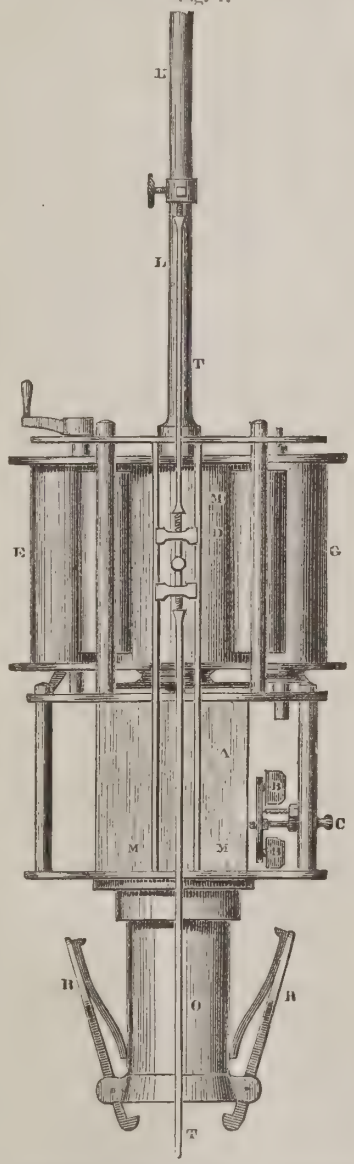
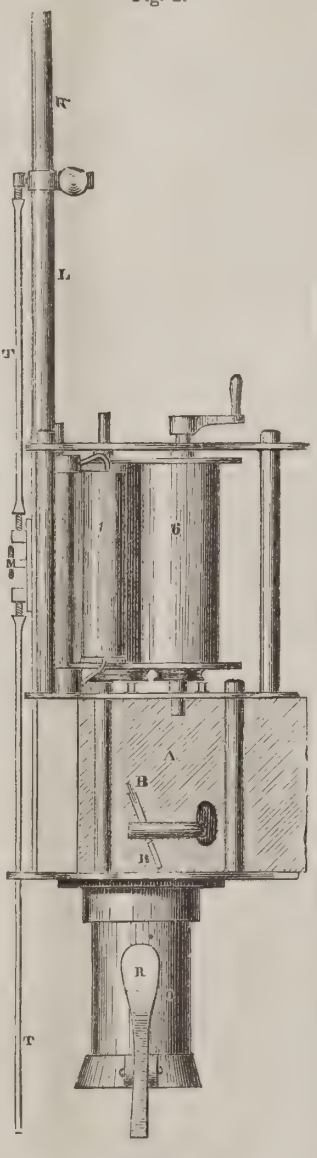
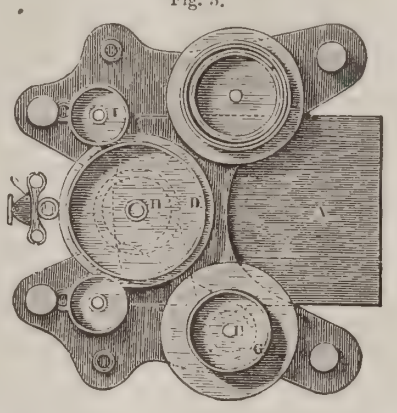


Fig. 2.



the surface. When exposed to the action of waves, the pole is found to rise and fall but little, particularly if the waves are moving quickly, as the pressure of the water on the small horizontal surface exposed is too little to overcome, to any great extent, the inertia of the pole during the time that the wave is passing it. We extract the following description from a cotemporary (*Engineering*), by whom, if we mistake not, it was taken from the recent transactions of the Institute of Naval Architects. Surrounding the pole is an annular float, 12 inches in diameter and about $1\frac{1}{2}$ inch thick; this float being made partly of cork and partly of oak, for a reason that will be explained presently. The float slides freely on the pole, and is kept in a horizontal position by light stays of iron wire, which connect it to a ring placed around the pole at a short distance above it. The pole being, as we have said, almost motionless, the float rises and falls upon it as the waves pass by; and as the pole is painted with rings of different colours, it is possible, by watching the motion of the float, to determine, with some degree of exactness, the height of the waves. As, however,

Fig. 3.



the motion of the waves is frequently rather rapid, Admiral Paris has considered it better to add to the instrument an arrangement by which the height of the waves passing it is registered. Admiral Paris' first idea was to attach a rope to the float and pass this rope over pulleys at the top and bottom of the pole, the motion thus

Fig. 4.

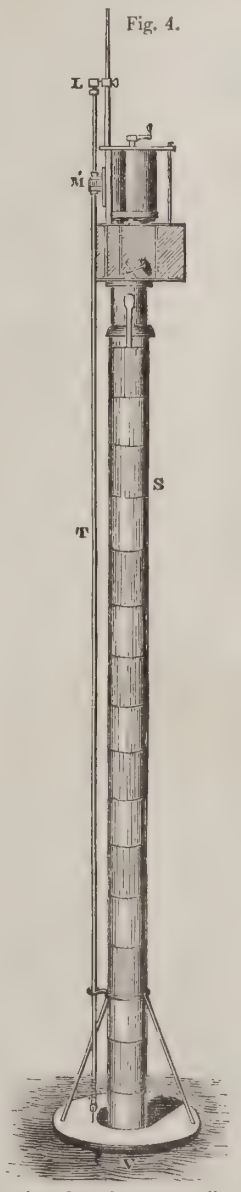


Fig. 5.

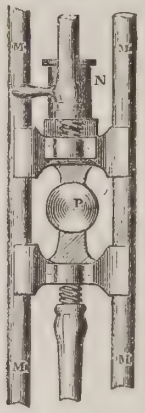


Fig. 6.

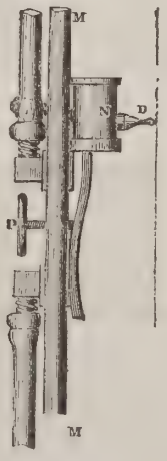
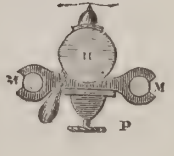


Fig. 7.



communicated to the upper pulley by the rising and falling of the float being made available to work registering mechanism. This idea was, however, abandoned, and the plan ultimately adopted, which was suggested by Admiral Paris' son, was to connect the float with a fixed point at the top of the pole by a tube of india-rubber,

and to attach a tracing point to this india-rubber at a short distance from its upper end. As the india-rubber elongates equally throughout its whole length as the float rises and falls, the tracing point receives an extent of motion bearing the same proportion to the motion of the float that the total length of the india-rubber does to the distance between its upper end and the point at which the tracing point is attached. The india-rubber is about $\frac{1}{4}$ inch in diameter, and is of such length that when the float is in its highest position the india-rubber is still in a state of slight tension, whilst at the same time it is not too much strained when the float falls to its lowest level. It is on account of a certain amount of weight being necessary to stretch the india-rubber that the float is, as we have already mentioned, made partly of oak and partly of cork. The arrangement of the registering mechanism is shown in the engravings. In these, A is the box containing the clockwork; B, the fly, by varying the obliquity of the wings of which the speed of the train can be regulated; C, the stopper for the fly: D, the cylinder, which is directly driven by the clockwork; E, the cylinder in which the registering paper is coiled; F, a spring pressing lightly on the bottom of the last-mentioned cylinder to prevent its revolving too freely; and G, the cylinder on which the paper is coiled after it has passed the tracing point, this cylinder being driven from the cylinder, D, by means of two pulleys of different diameters, and a connecting cord, as shown by dotted lines in Fig. 3. I is a small cylinder of wood, used to press the paper close to the cylinder, D; K is a rod on which slides the ring, L, which is used to fix the upper part of the india-rubber tube, T T. The line is traced upon the paper by an untwisted cotton thread, O, which projects from the neck of the ink-holder, N, this ink-holder being connected with the tube of india-rubber, T, and being furnished with branches working on the guide-bars, M. The distance of the ink-holder from the paper is regulated by means of the screw, P; and it is found that blue ink acts better as a marking material than black, as it dries more quickly. The whole apparatus is fixed to the top of the pole, S, by means of the socket, Q, a spring hook, R, being provided to keep it in place. T is the india-rubber tube connected to the float, V, and the ring, L, this tube being also, as we have stated, attached to the ink-holder at M^1. In using the instrument, the position of the tracing point has to be adjusted, so that when the instrument is floated in still water the point bears against the paper at the middle of its height, and the speed of the clockwork should also be tested and adjusted by shifting the vanes of the fly. When a diagram is to be traced, the ink-holder should be supplied with ink at the last moment, and the instrument gradually immersed, a log line being previously attached to it for the purpose of hauling it in. When the waves are only about 3 feet in height, it is best to make the experiments in a small boat; but in a heavy sea the oars of a rowing boat are troublesome, and the instrument is liable to be damaged. A number of experiments were made by Admiral Paris' son with the wave-measurer off Brest, when the waves were running to a height of 3 metres, or about 10 feet, the vessel used being only a small schooner, called the *Esmeralda*, a vessel 59 feet long, 13 feet beam, and 40 tons tonnage. According to the speed at which the paper is run, the wave lines traced on it appear to be longer or shorter; and to complete the observations it is therefore necessary that the speed at which the waves travel should be measured, and this can be readily done by the aid of a float at the end of a log line, the speed of the vessel from which the observations are taken being at the same time ascertained by taking bearings. In making experiments with the *Esmeralda*, the speed of the waves was found to be from seven to eight metres per second, or from about 14 knots to 16 knots per hour. The heights of the waves, as given by the instrument, have also to be corrected to some extent for the slight vertical movement of the pole itself. From some experiments made off the Point of Portzic, near Brest, when the floating instrument was observed through a theodolite on shore, it was found that in a heavy sea, when the waves were running to a maximum height of a little over 10 feet and a mean height of 7 feet 8 inches, the vertical motion of the pole amounted to 12 per cent. of the height of the waves. This proportion will, however, vary under different circumstances; short, quickly-moving waves producing a less, and long, slowly-moving waves a greater amount of vertical motion. The greatest deflection of the instrument observed during the strongest winds to which it was exposed, was 10° from the vertical.

The New Breech-loader for the British Army.—Our readers are aware that a competition has been going on for some time at Woolwich, under the superintendence of a select committee appointed by government, for the purpose of determining what is to be the future rifle for the British army, and that prizes of £1000 and £600 respectively have been offered for the best system of breech-loading arms, fulfilling certain conditions. There were upwards of 100 different arms sent, in the first instance, for selection, and nine systems combining the necessary qualifications were chosen. Among these was the celebrated breech-loader of our well-known townsman, Mr. Henry, for which he received a prize of £300. The second stage of the trials was of the most critical nature, all manner of experiments being tried to produce a failure in some way or other—extra charges, damaged ammunition, sand, and earth being freely used to try the capabilities of the rifles to the utmost extent. The Snider converted Enfield was included in the list for the purpose of comparison. One rifle after another gave way in some particular weakness, with the exception, we understand, of Mr. Henry's; which proved itself, as it has already done at all the great rifle gatherings, the most nearly perfect weapon that has yet been produced, and is, consequently, in the honourable position of being in the first place, and that in the face of great difficulties, against makers and systems having every means and appliance at their disposal. The report of the select committee will shortly be published, and will, no doubt, be very interesting in its details of the merits of the various arms.—*The Scotsman.*

Re-manufacture of Paper for "Greenbacks."—The paper mill has only been in operation a few months, and the machinery is run by a horizontal steam-engine of about fifteen horse-power. The "stock" used in the manufacture of the paper here is one-half cancelled bank and treasury notes, mutilated currency, &c., and one-half scrap paper, accumulated in the Treasury department and its bureaus. This stock is first put into a steam-chest containing strong alkali on the floor below the basement. The steam-chest is a horizontal cylinder, about 16 feet long and 6 feet in diameter. Steam is then let on until the stock is reduced to pulp. When complete, the pulp is dropped into vats below the cylinder, and is at this stage of the process a thick fibrous mass, very dark in colour, because of the ink, from which it has not yet been freed. It next undergoes a washing process, to cleanse it from ink and such impurities as discolour it, or which would destroy the evenness of the paper, and is carried by dumb-waiters to the upper floor, where in the lime-bleach vats it is steamed in a solution of lime for some hours, until it is free from stains and yellowness; after this process the pulp is in fibrous masses of pure white. The pulp next undergoes another washing and beating process, in large tubs, in which a cylinder armed with knives constantly revolves, and in which the water is continually renewed. Every particle passes under the knives and through the running water. This operation removes the last impurities, and makes a fine pulpy mass, of equal consistence throughout. It is then let off into a great vat on the floor below, 12 feet in diameter and 9 feet high. In this vat, called the stuff chest, it is mixed with more pure water, and kept constantly agitated to insure an equal distribution of the paper material in the liquid mass. The colouring matter is now put in, if yellow envelope paper is being made. From the stuff-chest it is pumped up into a reservoir diluted with a considerable addition of water, and fed to the Fourdrinier machine, which receives the milky fluid at one end and piles up the finished paper at the other. The stuff, of the consistency of rich milk, is first received into the screen-box, where it spreads itself over a frame set with horizontal slats, close together, and finally runs through them upon a fine wire sieve, through which it also disappears, the whole machine being kept in agitation to facilitate the process. The slats and sieve catch any sand, metallic particles, &c., which might remain in the pulp after the beatings and washings we have already referred to. From the box beneath the sieve the stuff falls in a sheet, or rather shower, of the proper width upon an endless belt of wire gauze, over which it is distributed of the proper thickness for the quality of paper to be made, by a gauge for the purpose. The wire belt revolves upon small metal rollers placed very close together, and continues to revolve in the same direction, carrying the paper forward as long as the machinery is in motion. It has not only a constant motion forward, but from side to side, thus weaving the fibrous material into a sort of felt, which makes the paper much stronger than by the old cylinder machine, which had a wire-cloth cylinder revolving in the pulp, which took up a thin coat of fibrous material on its outside, the water draining through into the interior of the drum. Having no lateral motion, the fibre of the paper made upon it was laid all in one direction. The stuff is kept of the right width at first on the wire belt by strips of woollen cloth, but in passing along the water is precipitated from it in a smart shower beneath the machine, and it soon gets firmer. This drying process is hastened by the three suction boxes, which are of metal, about 6 inches wide, and perforated with small holes on top. The air being exhausted from these by a steam pump, the newly-formed paper in passing over them has the water forced from it into the boxes by the pressure of the atmosphere. Between the first and second suction boxes slowly revolves a hollow cylinder, called the "dandy roll," covered with intersecting lines forming rhomboids, in each of which is a type of a capital T. The "dandy roll" prints this (or whatever other pattern it bears) on the semi-fluid paper, forming what is called the water-mark. Any sort of water-mark may be put in, and it is hereafter designed to make this paper for fractional currency with different designs, making it almost impossible to counterfeit or alter it. From the wire gauze the new paper, now very firm but not yet self-sustaining, passes on to a second endless belt or thick felt which conveys it between two large cylinders called press-rolls, and thus through two more sets, by which time the moisture is quite forced out, and it is able to pass forward to the heating rollers without any support. There are six series of these drying rollers through which the paper passes up and down and in and out, losing some of its moisture and gaining strength at every step in the journey, until when it passes through one set of calenders to smooth it at this point it may be considered finished for some purposes, and there is a roller here on which it may be wound if necessary. In making the finer qualities of paper, however, more remains to be done. The sheet is now very wide, and it may be necessary to cut it lengthwise. For this purpose it passes over a round iron bar, two or more revolving knives slitting it to the required width. From this bar the paper travels through a trough of sizing made of gelatine, and then through other rollers which press it smooth, but not quite dry again, and then it meets a revolving cylinder with a sharp horizontal blade which cuts it off into sheets of the required length. The sheets fall into the "lay-boy," a machine which carries them to a table and lays them in a pile very neatly. From thence the sheets are taken to the drying-room and hung on racks. After being left a day or two to dry, they are taken to the calender machine and passed through a set of heated and polished rollers, from which they emerge hot, shining, and smooth. From the point where the Fourdrinier receives the pulp to the roller where the band of paper is cut into sheets the material travels 300 feet, and the machine makes 90 to 100 lbs. of paper every hour.—*Washington Star.*

Drainage Works in Hungary.—The lake of Neuseild, in Hungary, on the confines of Austria, is now completely drained and dried, and the land so obtained is about to be placed under cultivation. It contains eight square miles of virgin soil, and the belief is that it will prove to be extremely fertile. A canal has been made across it, to carry off whatever water may accumulate. The land is given to the neighbouring proprietors, and Prince Esterhazy and the convent of Heiligenkreuz will receive the largest share of it. This extensive tract of land reclaimed from nature, lies close by the lines of railway from Vienna to Raab, and from Vienna to Oedenberg, and a projected line from the latter town to Presburg will run still nearer to it.

APPLICATIONS FOR
PROVISIONAL PROTECTION FOR INVENTIONS
UNDER THE PATENT LAW AMENDMENT ACT.

☞ When the city or town is not mentioned, London is to be understood.

2d January, 1868.

18 M. A. Hamilton, Chancery Lane—Churn
19 E. J. and W. A. Kruss, Hamburg—Camera
20 E. Izod, Grocers' Hall Court—Finishing of stays

3d January, 1868.

21 J. Cox, Birmingham—Fastening sleeve links
22 J. S. Cockings and F. Potts, Birmingham—Welded iron tubes
23 T. P. A. Key, Rotherham—Scaffolding
24 C. Long, Knightsbridge—Eliminating a portion of the azote in furnaces
25 J. and B. Dellagana, Shoe Lane and Clerkenwell—Printing machines
26 M. E. Roy, Upper Norwood, and L. Prevett, Penge—Receptacle for containing needles
27 M. J. Frisbie, New York and Fitzroy Square—Feeding fuel into furnaces

4th January, 1868.

28 J. T. Emmerson and J. Murgatroyd, Heaton Norris—Iron
29 W. W. Morley, Woburn—Printing of paper bags
30 W. J. Blinkhorn, St. Helens—Smuffless dip candles
31 W. E. Newton, Chancery Lane—Mechanical arrangement
32 P. Spence and W. A. Smith, Manchester—Storing meat for transport
33 W. H Atkinson, Aldersgate Street—Cleansing and sweetening casks
34 A. Albini, Genoa and New Broad Street Buildings—Cartridge belts
35 W. B. Gray, Whiteabbey—Spinning and twisting machines
36 G. Mudge, Notting Hill—Adjustable lock furniture
37 J. Nixon, Westbourne Terrace—Transferring coal from railway waggons into barges

6th January, 1868.

38 G. Platts, Stockport, W. Tate and W. H. Bailey, Salford—Laying fog-signals
39 E. R. Southby, Lanark—Separating paraffin from its solutions
40 E. Gourdin, Paris—Lighting cane
41 T. Stokes, Kidderminster—Piled fabrics
42 J. R. T. Mulholland, Belfast—Bobbin-holder
43 J. Combe, Belfast—Winding
44 F. Chamberlain, Bredecof Court—Steam-boiler and other furnaces
45 J. Gardner, Edinburgh—Projecting liquids

7th January, 1868.

46 F. W. Hartley, Westminster—Optical illusions used in conjunction with the magic lantern
47 E. Myers, Strand, and G. A. Cannot, Pudding Lane—Permanent way of railways
48 C. D. Abel, Chancery Lane—Removing sulphur from metals.—A com.
49 C. Hutchinson, Holloway—Liquid meter tap
50 S. Etey, Great Windmill Street—The publication of certain journal books
51 H. M'Evoy, Birmingham—Fastenings for drapery
52 J. Maury, Liverpool—Metallic straps
53 W. T. Tongue, Wolverhampton—Lamps
54 J. Granville, Liverpool—Lowering boats from ships
55 G. Smith, Liverpool—Lubricating machinery
56 J. B. Dunn, Liverpool—Buckle or tie
57 H. Smyth, Little Trinity Lane—Umbrellas
58 W. Avery, Redditch—Needle-cases
59 G. Davies, Lincoln's Inn and Glasgow—Combining wrought and cast iron.—A com.
50 G. Warsop, Nottingham—Mangles
61 J. L. Norton, Ludgate Hill, and W. H. Bailey, Salford—Indicating the pressure and temperature of liquids
62 G. Warsop, Nottingham—Washing machines
63 G. E. Donisthorpe, Leeds—Fixing joints
64 P. Spence, Manchester—Roasting copper
65 B. J. Heywood, Holloway—Coffee roaster

8th January, 1868.

66 M. Grant, Camden Road—Playing cards
67 J. Tomlinson, Rochdale—Twisting and untwisting flax
68 L. Simon, Nottingham—Laying metal leaves on printed surfaces
69 S. Goldstein, Manchester—Gentlemen's wearing apparel
70 M. Walker, Strand, and G. H. Money, Jermyn Street—Breech-loading small-arms
71 F. F. Ommanney, Salford, and E. Scott, Manchester—Raising water for feeding boilers
72 C. Pontifex, Balls Bond—Presses
73 W. H. Bailey, Salford, and J. W. Lowther, Manchester—Lubricating tallow cups
74 G. W. Bacon, Strand—Gymnastic purposes
75 R. Girdwood, Edinburgh—Transmitting samples or materials by post
76 J. Dawson and J. Howarth, Bacup—Looms for weaving
77 S. Benjamin, Bayswater—Receptacles for coin.—A com.
78 W. F. Kenworthy—Purifying drains and sewers
79 W. E. Newton, Chancery Lane—Propelling vessels.—A com.
80 T. Greenwood, Leeds—Preparing silk to be spun.—A com.
81 J. Petrie, jun., Rochdale—'Brats' for conveying wool
82 J. Tucker, Old Lenton—Dressing fabrics and yarns
83 J. Tucker, Old Lenton—Paper
84 W. R. Lake, Chancery Lane—Cutters.—A com.

9th January, 1868.

85 C. J. B. King, Great Portland Street—Tanning of skins or hides
86 C. H. Newman, Brentford End—Unintoxicating malt liquors
87 S. G. Archibald, Edinburgh—Preparing paper
88 G. A. Heath, Greenwich—Sash fastenings
89 R. Winder, Farningham—Folding machine
90 O. H. M'Mullen, Hertford—Mashing machine

10th January, 1868.

91 J. Vivey, Paris—Lamps
92 J. Lewtas, Manchester—Holding and releasing the cords of blinds
93 J. H. Glew, Fitzroy Square—Boots and shoes
94 S Mortimer, Bradford—Combing wool
95 J. Fawcett, Kirton-in-Lindsey—Cattle food
96 J. M. Rowan, Glasgow—Artificial fuel.—A com.
97 G. Davies, Lincoln's Inn and Glasgow—Self-supplying pen
98 J. G. Tongue, Chancery Lane—Sewing the backs of books.—A com.

11th January, 1868.

99 H. Cochrane, Middlesborough-on-Tees—Making moulds for castings
100 W. Champness, Manchester—Ornamenting wearing apparel
101 C. S. Lemon, Liverpool—Shirt fronts
102 A. Budenberg, Manchester—Steam-hammers.—A com.
103 J. Pilling and R. Scaife, Colne—Spinning
104 J. and W. Hurst, Halifax—Clog soles
105 J. Sommervell, Kendal—Obtaining and preserving alimentary substances
106 W. W. Hooper, Bow—Signals on board ship
107 J. C. Ellison, Rawfolds—Folding fabrics
108 N. Hodgson, New Barnet—Engines
109 J. G. Tongue, Chancery Lane—Sizing the backs of carpets
110 W. D. Young, Edinburgh—Wedging and fastening fences
111 J. H. Johnson, Lincoln's Inn Fields—Pipes for smoking.—A com.
112 T. Whitwell, Stockton-on-Tees—Furnaces
113 G. Ireland, Handsworth—Cruet frames
114 T. S. Ellin, Sheffield—Self-securing skate

13th January, 1868.

115 M. A. Hamilton, Chancery Lane—Device for holding pens
116 P. Pittar, Gresham Street—Mineral and rock-drilling apparatus
117 J. M. Kirby, Northampton—Generating steam
118 W. Firth, Edinburgh—Valve made from india-rubber
119 C. A. Watkins, Soho Square—Ties for painting

14th January, 1868.

120 T. Wood, Liverpool—Railway carriages
121 W. E. Gedge, Strand—Breech-loading fire-arms.—A com.
122 C. D. Abel, Chancery Lane—Woven fabrics
123 C. W. Lewis, Langham Place—Spirit level.—A com.
124 A. Cowling and W. Turner, Sheffield—Ornamentation of tape measure cases
125 J. C. Ramsden, Bradford—Looms

15th January, 1868.

126 T. Sagar and T. Richmond, Burnley—Looms for weaving
127 A. B. Boyer, Paris—Aerial cradles
128 F. and J. Alekan, Paris—Shirt fronts
129 W E. Gedge, Strand—Thin flexible blades
130 L. M. Becker, Basinghall Street—Laying the wires of electric telegraphs
131 G. Nimmo, Jersey—Composition for furnace linings
132 J. Lang, Paisley—Printing of music
133 D. Hodson and J. Dodd, Swetton—Cutting corn
134 J. Hudson and C. Catlow, Burnley—Looms
135 W. Aylife, Cropthorne—Boats
136 J. Williamson, Cornhill—Fastening ships
137 J. Parker, Glasgow—Textile fabrics
138 J. Kidd, Saint Paul's Wharf—Artificial light
139 J. Head, Newport Rolling Mills—Furnaces for puddling
140 W. Wilkins and W. C. Pollard, Leicester—Knitted reversible

16th January, 1868.

141 T. Travis, W. H. Prince, and J. Tomlinson, Rochdale—Clearing and smoothing yarn
142 J. Eggleton, Clapham—Bellows regulators
143 J. J. Ashworth, Manchester—Looms
144 J. Tolson and J. Boothroyd, Dalton—Mule spinning machinery
145 R. Schneider, Manchester—Piled fabrics
146 C. F. Brooman, Fleet Street—Gas heating
147 H. B. and A. Mullord, Hoxton—Ornamentation of bonnets
148 J. Wood, East Wemyss—Windows
149 J. A. Jones, Middlesborough—Iron and steel
150 W. Betts, City Road—Capsules
151 J. G. Rollins, Old Swan Lane—Baskets.—A com.
152 T. Nash, Great Dover Street—Stoves
153 G. E. Reading, Birmingham—Busk fasteners
154 C. D. Abel, Chancery Lane—Movable switches.—A com.
155 F. Postill, Scarborough—Kilns
156 W. E. Newton, Chancery Lane—Shaping sword blades.—A com.

17th January, 1868.

157 J. Batchelor and J. Smith, Kidderminster—Power loom
158 R. Heathfield, Birmingham—Nails and tacks
159 J. Moorhouse, Wakefield—Cone Drawing
160 H. C. Lobnitz and A. Buquet, Renfrew—Propelling ships
161 S. and E. Burrows, Dukinfield—Employing waste steam
162 J. Hosking, the younger, Gateshead-on-Tyne—Cutting heads
163 J. Young, Stewarton—Washing
164 H. Aitken, Falkirk—Treating iron ores
165 J. Crossley, Halifax—Washing printed yarns
166 J. M. Napier, Lambeth—Cutting and dressing metals
167 D. A. Fyfe, Edinburgh—Paper pulp from wood
168 N. H. Rolfe, Hull—Cutting laths
169 W. R. Lake, Chancery Lane—Treating wood veneer.—A com.
170 G. S. Fisher, Buffalo, U. S.—Cutting hay
171 J. Winter, the younger, Soho—Filling glass bottles

18th January, 1868.

172 J. Millward, Birmingham—Propelling ships.—A com.
173 T. B. Kay and F. Hamilton, Bolton-le-Moors—Carding engines
174 H. H. Lloyd, Douglas—Coffins
175 B. T. Moore, Isleworth—Protecting water pipes from frost
176 E. Dorsett, London Street—Utilization of coal tar
177 J. Whiteley, Huddersfield—Twining
178 H. Kershaw, Laister Dyke—Spinning worsted
179 H. A. Bonneville, Paris—Fly cover for protecting stitch books.—A com.
180 H. A. Bonneville, Paris—Ribbon looms.—A com.
181 H. A. Bonneville, Paris—Ribbon looms
182 A. Bochkoltz, Vienna—Self-acting valves
183 B. J. Heywood Colmar, Holloway—Pencil cases
184 J. Davidson, Woolwich—Bullets
185 W. E. Newton, Chancery Lane—Ovens for firing or baking porcelain.—A com.
186 J. Carr, Clapham, and C. Lucop, Drummond Road—Meat and other biscuits
187 G. S Fisher, Buffalo, U. S.—Links or couplings for harness
188 F. J. Baynes, Islington—Kitchen ranges
189 D. Timmins, Stourport—Motive-power engines
190 G. Gopsill, Birmingham—Dress fastenings

20th January, 1868.

191 J. Davies, Smethwick—Shaping malleable materials.
192 T. G. F. Dolby, London—Valve for supplying fresh air into feeding bottles
193 W. Firth, Edinburgh—Pumps, syringes, and spray-producers
194 M. Robinson, Accrington—Expanding and contracting combs
195 R. Carling, Manchester, and T. Carling, Bolton—Lubricating the interior of frictional surfaces of steam
196 J. Woodely, Send—Signalling in railway trains
197 W. R. Lake, Chancery Lane—Wood rings or washers.—A com.
198 W. R. Lake, Chancery Lane—Pegging the soles of boots and shoes to their uppers.—A com.
199 A. M. Clark, Chancery Lane—Steam boilers.—A com.
200 J. H. Johnson, Lincoln's Inn Fields—Burning fluids.—A com.
201 J. Parsons, Birmingham—Double barrel of breech-loading fire-arms
202 A. V. Newton, Chancery Lane—Sewing machines.—A com.

21st January, 1868.

203 E. Thomas, Aberdare—Miners' safety lamps
204 J. F. Spencer, Sunderland—Steam boilers
205 J. F. Spencer, Sunderland—Regulating the valves of steam-engines
206 C. W. Brown, New Cross—Truncheons
207 J. L. Davies, Manchester—Securing corks in bottles.—A com.
208 C. R. Havell, Reading—Water heaters
209 W. Dickins, Daventry—Boots and shoes
210 L. N. Le Gras, Wardour Street—Churns
211 T. V. Lee, Macclesfield—Producing charcoal
212 W. J. Coleman, St. Maryat Hill—Beer, wine finings
213 J. J. Long, Glasgow—Matches
214 J. H. Johnson, Lincoln's Inn Fields—Indicating positions of heavenly bodies.—A com.
215 J. H. Johnson, Lincoln's Inn Fields—Furnaces.—A com.
216 W. Davis, Gainford—Fastening bags made of paper

217 W. E. Newton, Chancery Lane—Rotary engines.—A com.
218 H. Brinsmead, Ipswich—Thrashing machines
219 G. T. Bousfield, Brixton—Liberating the colouring matter of madder
220 A. B. Brown, Wandsworth Road—Actuating valves of engines

22nd January, 1868.

221 F. L. H. Danchell, Horwich—Preparing and drying peat
222 J. Dixon, Abchurch Yard—Floating saloon bath
223 P. Harrower and J. C. Stuart, Glasgow—Spray-producer
224 C. R. Broadbent, Boston—Shoes
225 C. E. Brooman, Fleet Street—Producing colouring matter
226 W. Thompson and T. Strather, Kingston-upon-Hull—Mills for Grinding
227 C. E. Brooman, Fleet Street—Extracting colouring matter.—A com.
228 S. Bennet, Dalston—Drying grain
229 E. Tomlinson, Hatton Garden—Ornamenting articles made from wood
230 R. Needham, Dukinfield—Valves for steam-engines
231 T. Goune, Pall Mall—Canteen
232 C. S. Barker, Regent's Park—Organs
233 T. W. Gray, Limehouse—Lightning conductors
234 W. Dennis, Aldermanbury—Letter boxes
235 T. Cook, Peckham—Boots and shoes

23rd January, 1868.

236 T. Rowley, Manchester—Soles and heels of boots and shoes
237 W. Oram, Salford—Heating buildings
238 D. Y. Stewart, Glasgow—Cast-iron pipes
239 H. Hodge, Southport—Gas stoves
240 G. Kirk and W. Murray, Huddersfield—Self-acting mules for spinning
241 J. C. Sanders. Birmingham—Door-knobs
242 W. Botomley, Bramley, Leeds—Milling machinery
243 J. Goulding, Bradford—Looms for weaving
244 H. J. Dickinson, Gray's Inn Road—Tables adapted to be employed for playing billiards
245 H. M. Ragland, Fish Street Hill—Tanning hides.—A com.
246 G. Allibon, Worcester, and A. Manbre, Baker Street—Steam-boilers
247 S. Price, Highbury—Turning on and off the supply of gas to houses
248 M. Tildesley and J. Bird, Willenhall—Furnaces
249 C. and A. Garcin, Colmar—Sewing machines
250 G. Severn, Hampstead Road—Valvular apparatus for giving vent to and for excluding air from casks

24th January, 1868.

251 W. J. Jennings, Little Bowden—Permanent way of railways
252 J. and D. Storer, Glasgow—Vessels for holding liquids
253 A. Small, Glasgow—Removing excrements
254 E. W. De Russett, Lewisham, and R. F. Dale, Shoe Lane—Water closets
255 A. M. Clark, Chancery Lane—Lubricating machinery exposed to the action of steam.—A com.
256 C. Woodroffe, Rugby—Travelling post offices
257 T. L. G. Bell, Plaistow—Preparing oxide of iron for purifying gas

25th January, 1868.

258 K. J. Winslow, Twickenham—Rotatory motion to axles
259 J. Mason, Sunderland—Fuel
260 J. M. Lewis, Pimlico—Securing watches
261 C. W. Dixon, Wickham Market—Rotating slide valves
262 J. and T. A. Boyd, Glasgow—Winding machines
263 C. Kilburn, Holloway—Life and swimming belts
264 C. E. Brooman, Fleet Street—Breech-loading fire-arms.—A com.
265 C. Ritchie, Brixton—Utilizing heat for warming and ventilating
266 T. Robinson, Widnes—Formation of fortifications
267 R. G. Wells, and D. Jones, Birmingham—Producing optical illusions
268 E. J. W. Parnacott, Leeds—Elastic rollers
269 A. C. M. Prince, Charing Cross—Bell pull for door bells.—A com.
270 A. M'Dougall, Manchester—Burning sulphur ores
271 J. H. Johnson, Lincoln's Inn Fields—Melting and heating metals.—A com.
272 T. Wirth, Frankfort-on-Maine—Decomposing water, oil, and other substances.

27th January, 1868.

273 J. Rowley, Camberwell—Process for the ornamenting of candles
274 A. Middlemist, Hull—Increasing the heat and draught in stoves
275 A. H. Thurgar, Norwich—Securing the corks of bottles of champagne and other effervescing liquids
276 J. J. Hicks, Hatton Garden—Backs and handles for hand mirrors
277 T. Dickinson, Lancaster—Drawing off water
278 G. Kellogg, Edward's Hotel—Hats, bonnets, and other coverings for the head—A com.
279 W. E. Rendle, Cavendish Square—Protecting fruit trees and other plants from frost
280 W. E. Newton, Chancery Lane—Grinding and polishing concave substances.—A com.
281 W. E. Newton, Chancery Lane—Forming hat bodies and other fibrous materials
282 W. Ellis, Colwick Lane—Rotary machine for cutting wood by hand or steam power
283 F. N. Clerk, Wolverhampton—Washers
284 J. Roberts, West Bromwich, and J. Morgan, Kidderminster—Joining metallic pipe

28th January, 1868.

285 W. Tranter, Birmingham—Fire-arms and cartridges
286 E. Egersdorff, Gray's Inn Road—Tips for boot heels
287 H. A. Bonneville, Paris—Preserving eggs.—A com.
288 H. A. Bonneville, Paris—Ribbon looms.—A com.
289 W. A. Gibbs, Gillwell Park—Drying wheat in the sheaf and other vegetable matters
290 W. H. Crispin, Stratford—Antiscorbutic biscuits
291 C. E. Brooman, Fleet Street—Candles.—A com.
292 G. N. Sanders, Paris—Increasing light in burners for gas
293 T. Hydes and J. Bennett, Sheffield—Consuming smoke
294 A. Pickering, York—Fancy confectionery
295 T. Corbett, Shrewsbury—Cleaning and separating grain
296 W. R. Lake, Chancery Lane—Pavement.—A com.
297 J. Pearson, Jewin St., and J. W. Young, Regent's Park—Refining or purifying oils
298 J. Brown, Stockton-upon-Tees—Cutting wood
299 R. J. Moser, Southwark—Bellows —A com.
300 A. C. Pilliner and J. C. Hill, Oakfield Works—Motive power for raising and compressing fluids
301 J. H. Johnson, Lincoln's Inn Fields—Lithographic printing machines
302 J. D. Brunton, Kentish Town—Cutting and dressing stone
303 W. H. Richardson, Glasgow, and W. Beardmore, Parkhead—Iron and steel
304 W. March, jun., Leicester—Lasts for boots and shoes

29th January, 1868.

305 C. A M'Curd, Camberwell—Sewing machines
306 R. Wilson, Manchester—Joints for conveying fluids through pipes
307 W. Snell, Westminster—Steam fire-proof safes.—A com.
308 W. Snell, Westminster—Fire-proof powder magazine.—A com.
309 S. B. Ardrey and S. Beckett, Manchester - Velocipedes
310 W. Tasker, Bradford—Opening and cleaning cotton—A com.
311 D. Law and J. Wharrie, Glasgow—Cast-iron pipes
312 G. Thornton, Chesterfield—Straw elevator
313 W. Guise, Redditch—Scouring needles
314 C. Riley, Whetstone—Combined threshing machine frame
315 S. M. M. Pinner and S. A. Varley, Holloway—Electrical train intercommunication
316 W. E. Newton, Chancery Lane—Self-acting brakes for carriages.—A com.
317 W. E. Newton, Chancery Lane—Breech-loading fire-arms.—A com.
318 J. H. Johnson, Lincoln's Inn Fields—Disintegrating and cleansing raw wool and woollen fabrics.—A com.
319 W. R. Lake, Chancery Lane—Furnaces for roasting ores.—A com.

30th January, 1868.

320 B. Dobson, W. Slater, and R. Halliwell, Bolton—Spinning
321 J. Radcliffe, Consett Iron Works—Puddled iron and steel
322 J. Grimes, Leicester—Soles and heels of boots and shoes
323 H. Aland, Lambeth—Rotary blowing fans
324 M. A. Hamilton, Chancery Lane—Cutting bread
325 W. Hartnell and S. Guthrie, Lincoln—Steam and other motive engines
326 E. T. Mainwaring, Tipton—Bale or metallic tie
327 T. Rowan, Glasgow—Removing sulphur and phosphorus from iron
328 B. Hayne, Broadwall—Connecting beer engine pipes with their taps
329 W. E. Newton, Chancery Lane—Window sun blinds.—A com.
330 W. Bull, Chancery Lane—Vacuum and pressure case moulds
331 C. H. Rocchner, Whitchurch—Paper machine
332 J. Thompson, Aldersgate Street—Feeding bottles for invalids
333 A. M. Clark, Chancery Lane—Adjustable wrenches.—A com.

31st January, 1868.

334 C. H. Adams, Birmingham—Portable metal buckets
335 E. Fleet, Walworth—Aerated liquids
336 J. Walker, Beeston, and J. Hudson, Bowling—Turning and cutting wood
337 J. H. Johnson, Lincoln's Inn Fields—Steam-engines.—A com.
338 E. Andrews, Huddersfield—Wearing apparel
339 H. A. Bonneville, Paris—Advertising vehicles.—A com.
340 H. Chapman, Westminster—Bolts, nuts, add washers
341 J. Mitchell, jun., and G. T. Graham, Dundee—Cutting woven fabrics
342 E. Bolton, Warrington—Gunpowder
343 G. L. Scott, Manchester—Steering ships
344 S. E. Howell, Sheffield—Suspension bridges
345 J. Livesey, Westminster—Substitute for glass
346 J. Frame, Glasgow—Transmitting motive power
347 A. M. Clark, Chancery Lane—Steam-engines.—A com.
348 G. Clarke, Hampstead—Fire-escapes

1st February, 1868.

349 G. Moulton, Manchester—Pentagraph engraving machines
350 J. V. Jones and G. J. Williams—Metallic tubes
351 R. C. Smith, Edinburgh—Sinks
352 H. Aitken, Falkirk—Treating iron ores
353 A. Clark and A. Van Winkle, Great Weld St.—Storing aerated waters.—Partly a com.
354 A. M. Clark, Chancery Lane—Utilizing and increasing the lighting power of gases.—A com.
355 D. Murray, York—Coverings for the head
356 J. Jameson, Gatesbead—Postage and other stamps

3rd February, 1868.

357 C. E. Brooman, Fleet Street—Steam and water valves.—A com.
358 B. Ford, Middlesborough-on-Tees—Hot air stoves for blast furnaces
359 J. Tolson, Dalton—Cleaning carding engines
360 J. and W. Weems, Johnstone—Heating and drying grain
361 M. A. Wilson, Kensington—Spring and other mattresses
362 J. Combe and J. Barbour, Belfast—Hackling and scutching flax
363 J. M. Domenech and J. P. Jonte, Paris—Combined photographic apparatus
364 J. H. Johnson, Lincoln's Inn Fields—Treatment of bones.—A com.
365 J. West, Plumstead—Preventing the formation of scale in steam boilers
366 C. Richardson, Gracechurch Street—Looms for weaving
367 W. R. Lake, Chancery Lane—Leggings.—A com.
368 H. B. Wright, Regents Park—Sweeping chimneys
369 J. Offord, Oxford Street, and S. W. Hale, Paddington—Public and private carriages
370 W. Wallis and G. Mant, Birmingham—Stands for boots and shoes

4th February, 1868.

371 J. H. Johnson, Lincoln's Inn Fields—Treatment of compressed and embossed wood—A com.
372 R. A. Jones, Aylesbury—Warming and ventilating
373 E. Grether, Manchester, and M. Bailey, Huddersfield—Cutting washers of india-rubber
374 J. Lewis, R. and E. Alston, Preston—Movable fire-bars
375 L. Desens, Charing Cross—Miners' lamps
376 J. Dewar, Kirkcaldy—Preserving food
377 R. Morton, Hackney—Refrigerators for cooling liquids
378 E. A. Morgan, Paisley—Spinning
379 T. Scott, Fushie Bridge—Drying grain
380 T. Cook, Peckham—Raising liquids from casks
381 A. C. Sterry, Ewell—Locomotive engines
382 T. Scott and R. Mowatt, Edinburgh—Lamps
383 P. Graham, Oxford Street—Stopper for bottles
384 J. Webster, Chelsea—Preventing incrustation in boilers
385 W. E. Newton, Chancery Lane—Steam boilers.—A com.
386 J. Pettman, Plumstead—Percussion fuses

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